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PRIORITIZING ASBESTOS REMOVAL FROM VARIOUSFACILITIES USING THE INSIGHT II EXPERT SYSTEM

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PRIORITIZING ASBESTOS REMOVAL FROM VARIOUS FACILITIES USING THE INSIGHT II+ EXPERT SYSTEM

by

Sharon L. Disher

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Advisor: Professor J. Hinze
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ABSTRACT

Use of the INSIGHT II+ expert system in conjunction with the 'Priasbes' knowledge base is recommended for use by facility managers or owners faced with a few or many locations of asbestos containing material (ACM) throughout their facilities. The 'Priasbes' knowledge base will recommend control measures to be taken for each location of ACM and will also assign a Criticality Index to the ACM location. This Criticality Index can then be compared with that of other ACM locations to prioritize the criticality of these locations to determine which locations should be controlled first.

INTRODUCTION

Facility managers are often faced with the enormous task of identifying the location of asbestos-containing materials in their facilities and determining the appropriate steps to take concerning the asbestos in their facilities. Complicated by unclear laws and regulations and the fact that asbestos has been used in over 3000 industrial and domestic applications this task is monumental in some facilities(9). The need for asbestos control is unquestionable. Although the control of asbestos is as yet unregulated by Federal law for public and private buildings, OSHA regulations exist which limit the asbestos exposure of workers in industrial settings and workers removing asbestos-containing materials from buildings. Additionally, the EPA has published regulations which apply to the industrial emission of asbestos fibers, the removal of asbestos-containing materials from buildings and the identification of asbestos-containing materials in schools.

These regulations were promulgated as a result of extensive research which has been conducted during the past century. Research has conclusively identified three fatal pulmonary diseases that develop from breathing asbestos fibers deep into the lungs: asbestosis, mesothelioma and lung cancer. Asbestosis is a non-cancerous disease of the lungs which is caused by the buildup of scar tissue around asbestos fibers which have been breathed into the lungs. Eventually the lungs lose their elasticity and the victim can no longer breathe with ease. In

the final stages, asbestosis results in the heart failure of the victim. Mesothelioma is a fatal form of cancer of the lining around the lungs and/or abdominal cavity. There is no cure for mesothelioma. Lung cancer, the largest killer of asbestos workers, is not linked exclusively to asbestos exposure. Cigarette smoking combined with the inhalation of asbestos fibers greatly increases the chances of an individual contracting lung cancer. These diseases have a latency period, the time period from initial exposure to onset of the disease, of three to more than fifty years.

Over 100,000 premature deaths have occurred in the past sixty years as a result of occupational exposure to asbestos (37). For asbestos exposure to be hazardous, the asbestos-containing material must be broken down so that it releases fibers into the atmosphere. Asbestos in this condition is said to be friable. That is, it can be crumbled or turned to powder by hand pressure. The released fibers are then free to enter the lungs and lodge themselves in tissue where their indestructible nature may begin to cause irreversible damage.

A good deal of concern and attention has been directed to the extensive presence of asbestos-containing materials in the nation's schools since children and young adults are at a greater risk of developing asbestos related diseases. Their young and immature immune systems increase their susceptibility to contracting asbestos-related diseases. Also, by being so young they have a longer remaining life span during which these diseases can develop.

Since June, 1983, the EPA has required all private and public schools to inspect, sample and analyze all friable materials for the presence of asbestos. All school employees and the parents of school children are to be notified of any findings of friable asbestos in the school facilities. However, if asbestos-containing materials are identified, regulations did not require any other action to be taken. The prudent facility manager, however, should ensure that friable asbestos-containing material is controlled or removed.

Industrial exposure to asbestos has been limited by OSHA to two fibers per cubic centimeter (2 fibers/cc) of air, since 1976. This limit applies to fibers that are longer than five microns. The National Institute of Occupational Safety and Health (NIOSH), has recommended since that time that this standard be lowered to 0.1 fibers per cubic centimeter. However, this revised standard has yet to be adopted.

EPA regulations pertaining to asbestos were initially issued under the National Emissions Standards for Hazardous Air Pollutants (NESHAPS), authorized by the Clean Air Act in 1973 (35). These regulations were revised in 1975 and 1978. They currently prohibit the use of all sprayed-on asbestos material as well as the visible emission of asbestos fibers when milling, manufacturing, demolishing, collecting or disposing of friable asbestos-containing material. In January, 1986, the EPA proposed a ban on all asbestos-containing products along with a ten-year phase out of all uses of asbestos (16). Although this proposal has not been passed, its chances for adoption are quite

good. Once passed much more pressure will come to bear on facility managers to take action to control the asbestos-containing materials in their buildings.

Three abatement measures are available to facility managers in order to control asbestos-containing materials: a) enclosure b) encapsulation, c) removal.

Enclosure is a control method used to isolate the asbestos-containing material from human contact in an effort to protect it from damage or disturbance and thereby prevent the release of asbestos fibers. The asbestos source, however, remains in place and may continue to release fibers behind the enclosure. Eventually the asbestos source will need to be removed. Enclosure is only a temporary measure that should be used in conjunction with encapsulation. It is not recommended for material that is highly friable or damaged by water.

Encapsulation consists of the covering or penetration of the asbestos-containing material with an approved sealant. This sealant binds together the asbestos fibers with other material components and thereby reduces the potential of asbestos fiber release when impacted. Encapsulation should be used only on granular, cementitious asbestos-containing material that does not release asbestos fibers when the encapsulant is applied. The encapsulant should not be used on fibrous or fluffy material or material that has been damaged by water.

Removal is the only sure method that totally eliminates the asbestos source. By completely removing the asbestos-containing material, the need for periodic inspections or maintenance of

the material is eliminated. This method can be used in all situations, however, replacement with a non-asbestos material will be necessary and proper removal techniques must be utilized or the fiber level concentration may be increased.

Since facility managers will most likely encounter asbestos in many locations throughout the facilities for which they may be responsible, it may be difficult to prioritize which situations are worse than others. The purpose of this research paper is to assist the facility manager to prioritize the action steps to be taken in a variety of locations where asbestos-containing materials have been found. This will be done by using an "expert system" software program.

THE ASBESTOS NIGHTMARE

In 1964, Dr. Irving J. Selikoff, Head of Environmental Medicine at the Mount Sinai School of Medicine, published the first incontrovertible evidence that asbestos was a mineral whose characteristics render it the potential to cause one of the greatest health disasters of this century. With a half-life equal to infinity (11), and the fact that once its fibers have infiltrated into an individual's lungs they remain there forever, asbestos has been named the cause of over 100,000 deaths (34) due to occupational exposure alone in the past sixty years. From these same exposures, it is expected to cause at least another 350,000 deaths before all effects of the past sixty years are felt (34). These numbers reflect only those individuals exposed to asbestos in their work areas. It does not include the exposures of millions of school children, spouses or children of asbestos workers, or the general public who for years has been subject to the airborne fibers of asbestos when merely walking down the street next to a demolition project or in one's home using a hand held hair dryer or refurbishing a room where asbestos fibers were released when a sheet of wallboard containing asbestos was cut to size. Although a known cause of fatal lung diseases for thousands of years, regulation or legislation to hold this dreaded mineral at bay have not been enacted until most recently (30).

History of Asbestos. Asbestos was discovered in the stone ages where it was used in the making of pottery. Asbestos cloth was used as "a funeral dress for kings" in the ruins of Pompeii (12). During the Middle Ages, asbestos awed the likes of Charlemagne, King Ferdinand, and Marco Polo with its ability to withstand fire.

Throughout the centuries, asbestos sources remained relatively dormant until once again this fibrous mineral was discovered in 1879 (11,12) in the mines of Thetford in Quebec, Canada. Its properties of incombustibility, high tensile strength and chemical resistance along with its ability to be woven made it the perfect substance for innumerable industrial applications.

One of the first industrialists to recognize the potential of asbestos was Henry Ward Johns. Together with another industrialist C.B. Manville, they introduced the first full scale manufacture of an insulating material made of plaster and asbestos fibers which had unlimited applications for use in the steam driven factories of their day. Despite Henry Johns death in 1898 from a "chronic lung disease" (30), the Johns-Manville Company was established in 1902. This company was to play a dramatic role, socially, politically and ethically in the asbestos revolution turned nightmare in the 20th century.

Problem Identification The Johns-Manville Company continued to grow through the first quarter of the century. During the Depression it bought out asbestos mines, construction material

firms, soundproofing firms, floor covering plants, insulation suppliers, etc. as well as patent rights for processes such as sound proofing and insulating wall surfaces, concrete-asbestos pipe making methods, and construction of all types of structural items.

Asbestos production worldwide had increased from 30,000 tons annually in 1910, (11) to 500,000 tons annually by 1935 (11),with the Johns-Manville Company being the largest producer of asbestos in the world. With the largest asbestos mine in Quebec, Canada (which supplied the United States with 90% of its asbestos)(30), and the largest asbestos laboratories in Manville, New Jersey, the Johns-Manville Company was a stronghold on the asbestos market as well as being extremely influential on the politicians of the day.

With a strong sales and promotional department, the Johns-Manville Company revolutionized the construction industry in the early 1930's by making asbestos a primary building material for all types of construction. Asbestos was used in insulation, sheetrock, ceiling and floor tiles, caulk, spackling, motor casing, etc. To promote innovation, Johns-Manville sponsored contests to develop new and creative ways to use asbestos. They published a magazine called "Asbestos" to promote and advertise these new uses. Asbestos use, therefore, became no longer limited to construction applications. Household uses such as draperies, convertible car tops, table covers and place mats, liners in washing machines, ovens, and toasters became popular. Theatre curtains, scenery,and motion picture screens were all

made of asbestos. Powdered asbestos was sold as artificial snow for home use or in schoolyards as filler for sandboxes. While all along the major producer of asbestos, the Johns-Manville Company, was making billions of dollars selling what they called "The Magic Mineral" (11).

Ironically, at the same time that the Johns-Manville Company was expanding the asbestos industry, as well as their bank account, the medical profession had developed a keen interest in the lethal effects of this "magic mineral".

Although ill effects of asbestos are recorded as early as the first century when the Greek geographer, Strabo, and the Roman naturalist, Pliny the Elder, wrote that slaves who wove asbestos cloth were dying from "sickness of the lungs" (30), it was not until the early 1900's when the effects of asbestos truly began to be studied.

In 1900, Dr. H. Montague Murray performed the first autopsy on a 33 year old asbestos factory worker at London's Charing Cross Hospital. It was during this autopsy that the first connection between the fatal lung disease, later to be named asbestosis, and asbestos was drawn. Several years later in 1904, an inspector for the Department of Labor in France, named Auribault, discovered a preponderance of worker deaths in an asbestos weaving mill that had been established in 1890.

In 1906, both Dr. Murray and Mssr. Auribault were called to testify before a Department Committee on Compensation for Industrial Diseases. Dr. Murray testified that "considerable trouble is now taken to prevent the inhalation of dust and so the

disease is not so likely to occur as heretofore" (11). Similarly, Mssr. Auribault testified that people younger than 18 years of age should not be allowed to work in dusty conditions.

Ignorance combined with primitive testing methods created the false security that adequate precautions were being taken to reduce the dust levels. Actually, during the first quarter of this century, nothing was done to control the dust levels in asbestos factories nor was any asbestos related disease research performed.

It was not until 1924 when Dr. W.E. Cooke, a British physician, published in the British Medical Journal the results of an autopsy he performed on a 33 year old woman who had worked for twenty years in an asbestos textile factory which had implemented no dust control practices. His article was republished in 1927 which generated a number of studies of asbestos-related diseases for the next four years in Great Britain.

In 1931, because of the conclusive link between asbestos and death by pulmonary fibrosis or asbestosis, as it became called, the British Parliament made asbestosis a compensable disease and required improved methods of dust suppression and exhaust ventilation in asbestos textile factories. Additionally, periodical medical examinations were required for asbestos textile workers and autopsies were required on all asbestos workers.

In the United States, however, despite the widely-publicized effects of asbestos fibers on the human lung, the Johns-Manville Company and another large manufacturer of asbestos, the Raybestos-Manhattan Company, used their considerable political power to suppress publicizing information about the fatal effects of their "magic mineral" (30).

The first published case in the United States of an autopsy performed on an asbestos worker was written in 1935, by Dr. Kenneth M. Lynch at the Medical University of South Carolina. His corpse was that of a 55 year old male who had died of asbestosis and lung cancer. At this time the United States had very few states where worker's compensation covered dust diseases. As a result, very few autopsies had been performed on American asbestos workers.

In 1936, the Journal of Industrial Health published a study in which 34% of all asbestos workers studied showed X-ray evidence of lung mutations (30). This study along with several others caused the U.S. Public Health Service, in 1938, to call for a limit on exposure to asbestos fibers in this country but no specific numbers were cited.

Several studies during the next twenty years served to name asbestosis as a source of lung cancer and although these facts were well publicized, the major asbestos companies along with the asbestos industries which had since developed were unwilling to acknowledge the relationship between asbestos exposure, asbestosis and lung cancer. Furthermore, they would not aid researchers in their investigations.

Despite the hinderance of the asbestos manufacturers, research continued to be performed on asbestos related disease. By 1961, through research performed in South Africa and Finland, inhalation of asbestos fibers was found to cause asbestosis (a disease which causes scarring of the lung tissue until it loses its capacity for air and causes the victim to suffocate), and various types of lung cancer. Not only were these diseases noted in asbestos workers but also in individuals exposed to asbestos fibers by living near the asbestos factories or living in the same household with an asbestos worker. Asbestos fibers easily become airborne and once inhaled they will remain in the lungs forever.

In 1962, Dr. Irving J. Selikoff, Head of Environmental Medicine at the Mount Sinai School of Medicine, accepted grants from the Health Research Council of New York City as well as private donations and set up informal clinics at several New York City union halls to test workers from two local chapters, New York Local 12 and Newark Local 32, of the International Association of Heat and Frost Insulators and Asbestos Workers. He studied the results of the tests performed and published his findings in the Journal of the American Medical Association in 1964 (11).

In October of that year, he planned the International Conference of the Biological Effects of Asbestos sponsored by the New York Academy of Science. It was at this conference that he presented his previously-published findings and supplied the first incontrovertible evidence that industrial exposure to

asbestos was hazardous (11). Additionally, he established a sound methodology for future research and documented that the combination of cigarette smoking and asbestos inhalation would greatly increase the chances of lung cancer.

Until Dr. Selikoff publicized his research results, the asbestos manufacturers of the United States had "kept secret" the effects of asbestos fibers on their workers. They had never publicized the dangers of asbestos, though they were quite aware of them, and they had never warned their workers of the potentially fatal conditions in which they were working. The Johns-Manville Company even had a confidential medical survey done in 1949 among their workers in one of their Canadian mines. The results of this survey indicated four workers out of 708 had normal x-rays (30). The rest of the worker's lungs contained varying degrees of mutations. Despite these results, the physician hired by Johns-Manville to do the study reported that "the men have not been told of this diagnosis, for it is felt that as long as the man feels well, is happy at home and at work and his physical condition remains good, nothing should be said" (51).

Several years prior to this study, in 1946, when the fatal effects of asbestos were known by the manufacturing companies, Johns-Manville and other asbestos manufacturers saw the successful results of the efforts of their lobbyists. They had succeeded in obtaining a wide-scale requirement by federal, state

and local governments that asbestos materials must be specifically required in certain applications in the building codes (30).

The asbestos manufacturers were not the only ones at fault when it came to promoting the use of asbestos. During World War II, asbestos use in this country's Naval shipyards for the overhaul and repair of ships was quite prevalent. With the pressure to get the ships repaired and back to sea, the hazards of the asbestos being used in the repairs was of little concern or priority in the minds of government officials. Complete ignorance of the asbestos hazard did not exist in 1943, i.e., the Navy Department and the U.S. Maritime Services published a booklet called "Minimum Requirements for Safety and Industrial Health in Contract Shipyards" which warned workers that asbestosis could be contracted from any "job in which asbestos is breathed" (30). Although workers were warned, the effects of asbestos inhalation usually take twenty to thirty years to become fatal. Since workers felt good and were secure in their jobs, they believed they had nothing to worry about.

By 1960 three million tons of asbestos was being produced annually worldwide (11). Dr. Selikoff's 1964 study and conference marked a turning point in viewpoints on asbestos by medical and health care professionals worldwide. Publicity of this study forced the Johns-Manville Company to place labels on the packages of their asbestos products warning users of the

potential hazards of asbestos. Still limitations on the production of asbestos had not been established by regulating agencies or legislation.

In 1968, the United States was importing nearly one million tons of asbestos per year mostly from Canada (11). Asbestos was used in over 3000 common types of domestic and industrial applications (11) . It had been combined with other raw materials such as Portland cement, plastics, or asphalt vinyl so that in some applications, despite the fact that it may have composed up to 50% of a product, it was rendered practically invisible. Asbestos use was common in all textiles, automobile products, construction and household products. Essentially, it was in every factory, piece of machinery, school and every home and, therefore, most likely in every set of lungs.

The Policy Process Continues.

Establishment of the Environmental Protection Agency and the Occupational Safety and Health Administration in 1970 established two new regulating agencies who would take the lead on setting regulating standards for the production of and exposure to asbestos by workers and the public.

In 1970, OSHA called for limiting asbestos in the workplace. They called this limitation a standard although it set no numerical limits and was voluntary on the part of the employer (50). In May of 1971, OSHA established a limit of twelve fibers per cubic centimeter to be the allowable standard for the work environment (50). (Only fibers longer than five microns were

counted.) This standard could be measured by taking samples of the air in the working environment with a special pump that filtered the air as it was collected. The filter material, after being chemically treated, would dissolve and leave the asbestos fibers visible for viewing with a special microscope. The fibers were then counted to determine the level of asbestos fibers in the air.

According to magazines articles at the time, OSHA appeared reluctant to set stringent asbestos exposure standards. It appeared as if they were being influenced by asbestos manufacturers who were concerned with having to possibly shut down plants or lay off workers if "harsh" standards were established too quickly (50).

However, in December, 1971, stronger pressure was placed upon OSHA to impose stricter standards in the workplace by the AFL-CIO, an agency that had become more and more concerned about the health of its workers. Therefore, emergency standards of five fibers per cubic centimeter were established by OSHA (50).

This standard, however, did not satisfy the AFL-CIO's health director, Sheldon Samuels, who complained that with 500 asbestos plants across the nation there were not enough inspectors to ensure compliance with the new standards (50).

In October of the same year, the Environmental Protection Agency added asbestos to its list of atmospheric pollutants after a panel of the National Research Councils Committee on Biological Effects of Atmospheric Pollutants recommended that restrictions be placed on asbestos emissions into the air (31). They asserted

that for half of a century it had been a well known fact that workers employed in asbestos industries die of lung diseases. The association between prolonged exposure to asbestos and bronchogenic cancers had been proven and therefore the population at large would most likely be affected. Furthermore, examination of lung tissue from a portion of the general population revealed that a greater number of people not working in the asbestos industry had inhaled and were retaining asbestos fibers (31). These fibers could enter the air through mining and milling procedures, by transporting asbestos ore, by disturbing natural rock formations, or by manufacturing and using asbestos-containing products. It was this panel's contention that the major sources of asbestos must be controlled in order to prevent concentrations in the atmosphere similar to those in industry (31).

After the continued publicity of the fatal effects of asbestos and additional studies which showed that asbestos workers have an eight times greater chance of dying from lung cancer than that of the general public (50), OSHA reduced its permanent standard for occupational exposure to asbestos from 5 fibers/cc to 2 fibers/cc. This new standard was to take effect in all workplaces containing asbestos by July, 1976. Shortly after OSHA's announcement, the New York City Council banned all sprayed applications of asbestos per Local Law, 1971, "Air Pollution Control Code".

In keeping with the Clean Air Act of 1970, the EPA in April, of 1973, announced a National Emission Standard for Asbestos which disallowed any visual emissions of asbestos when manufacturing or milling or demolishing a building containing asbestos. Additionally, they prohibited the sprayed application of any asbestos materials containing more than one percent asbestos. This prohibition did not include decorative materials, however, so wall coverings or textured ceilings could still be used by the construction industry.

Important to note is the fact that despite these "emission standards" required by the EPA, asbestos fibers are quite small and are impossible to see by the naked human eye unless they are in great concentrations. Limiting their elimination to only those that cannot be seen does not cure the problem. Any asbestos fibers that get into the lungs have fatal potential and the total existence or presence of any asbestos fibers should have been banned. However, with strong lobbying by the asbestos manufacturers, as had occurred with OSHA, the EPA was slow to establish and enforce their asbestos control standards.

It was not until two years later, in October of 1975, when the EPA finally included waste collection and disposal under the "no visible emission" standard. That same month, OSHA recommended lowering the occupational standard from 2 fibers/cc to 0.5 fibers/cc. In July of 1976, when OSHA's standard of 2 fibers/cc finally went into effect, the National Institute of Occupational Safety and Health (NIOSH), recommended that the standard be reduced to 0.1 fibers/cc. With increased knowledge of the

hazards of asbestos by these new agencies and by the general public, enough pressure was finally coming to bear to combat that of the asbestos manufacturers which had prevented or slowed the formulation of the standards in the first place.

In 1977, passage of the amendments to the Clean Air Act into Public Law 95-95, served to increase awareness once again of the quality of air that the public was breathing. New air quality standards were set as well as automobile emission standards. A National Commission on Air Quality was established and the EPA was directed to review criteria for the ambient air quality standards before 1981 and perform subsequent reviews every five years thereafter. With this new responsibility, the EPA announced in June, 1978, the total prohibition of all uses of friable sprayed asbestos materials. Unfortunately, a "loophole" existed that permitted firms to use sprayed asbestos if the asbestos was already in inventory (30).

A month later the American Cancer Society publicized its study of ninety-two asbestos factory workers that showed that an individual exposed to asbestos dust for only one month can contract lung cancer (32).

Shortly, thereafter, the Consumer Product Safety Commission, (CPSC), was notified by a television station that handheld hair dryers that were being used by 13 million Americans contained asbestos (37). Concern was intensified as these dryers were most commonly used in small bathrooms with little or no ventilation.

The CPSC dismissed the problem due to lack of severity as they had just hired a management consultant firm to perform a $20,000 study which concluded that asbestos was no longer used in hair dryer manufacture (37). The television station did its own research, however, and found that many hair dryers on the market did use asbestos as liners for the plastic casings and issued a public warning. Needless to say, a general recall was put out for all hair dryers using asbestos. Meanwhile, the CPSC blamed the management consulting firm for the blunder and the firm blamed the CPSC.

By early 1979, the fatal effects of asbestos fibers was commonly known among the general public as well as the politicians. In March of 1979, the Environmental Defense Fund, a Washington D.C. based group, backed by the National Education Association, the American Federation of Teachers and the National Parent-Teacher Association petitioned the EPA to inspect 87,000 public schools across the nation for the presence of friable asbestos (5).

In response, the EPA notified state officials of the high levels of asbestos in public schools and began initiating an assistance program to help school officials recognize and control friable asbestos. It must be understood, at this point that unless asbestos was friable (capable of being crushed by hand pressure to release asbestos fibers into the atmosphere), it was not considered hazardous. Asbestos which was contained in a solid

form so that the asbestos fibers were not free was not considered hazardous. This was applied to vinyl asbestos floor tiles, undisturbed pipe insulation, etc.

New York City found that one third of it's 1000 schools had elevated levels of asbestos fibers in the air (5). New Jersey found schools with asbestos levels 100 times higher than those allowed by OSHA (5). It was estimated that 15 million students and 1.4 million workers may have been exposed to loose friable asbestos in schools across the nation (28). The costs to identify and remove all the friable asbestos were astronomical. Detection of all friable asbestos alone was estimated to cost $60 million (46).

Action had to be taken but schools could not afford the price with their already slim educational budgets. The educators therefore turned to the Congress. The House Education and Labor Committee recommended on 15 May, 1979, in it's report to the House, (H Rept 96-197), that $30 million dollars be authorized for FY 80-82 for a program of grants to school districts to detect asbestos. Additionally, they recommended that another $100 million in twenty year interest free loans be distributed to school districts for the containment or removal of asbestos (3).

Objections from the floor of the House were minimal. The bill HR 3282 passed unchallenged mainly due to the deletion of a provision that would have required asbestos manufacturers to pay

part of the cost of detecting the asbestos. In an effort to get the bill passed quickly, this controversial provision was dropped (3).

Although this bill did not have time to reach the Senate before the end of 1979, the Senate had a similar bill, S 1658, which was a "watered down" version of HR 3282. It's provisions which were ultimately signed into Public Law 96-270, "Asbestos School Hazard Detection and Control Act of 1980", on 14 June, 1980, authorized the following (7):

-$22.5 million in FY 81-82 for grants to state and local education agencies for use in detection of asbestos.

-$75 million in each FY 81 and 82 for 20 year interest free loans for containment or removal of asbestos in areas of over 2500 square feet.

-Barred grant and loan funds to pay for more than 50% of the detection or control cost.

-Required the Department of Education to issue standards for detection and removal of asbestos.

-The attorney general to conduct a study on whether the federal government should sue to recover the costs of detection and removal of asbestos from asbestos manufacturers.

Despite Congress' initial good intentions to help fund the solution of asbestos problems in schools, they never appropriated the funds to make it work. Therefore, once again, the educators were stuck holding the ball with little or no funds to take care of this extremely hazardous situation (3).

The same problem was addressed in July, 1984, with the House bill HR 1310. Although named the Math-Science Bill, it held the provisions to transfer the asbestos program from the Department of Education to the EPA where it belonged and authorized funding by the EPA to aid in the removal of asbestos from school buildings. This bill authorized fifty million dollars each for FY 84 and 85 and $100 million each for the next five years for grants or twenty year interest free loans (26).

It had strong backing by both the House and Senate and was signed into Public Law 98-377 on 11 August, 1984 (9). Fiscal year 84 appropriations included the $50 million for the EPA program.

The Attorney General's Liability Report to Congress as required by PL 96-270, was published in September, 1981, and advised the public of its right to sue asbestos manufacturers, distributors, architects, and contractors to recover the costs of asbestos removal from any building. Since no money had been appropriated to schools to cover their expenses, they began to do so along with thousands of other firms and individuals. By August of 1985, $80 billion in claims had been filed against asbestos manufacturers or distributors for asbestos removal costs alone (44).

Not only were asbestos manufacturers being held liable for asbestos removal costs but they were also being sued for personal liability costs by workers exposed to asbestos over the past forty-five years. Lawsuits numbering over 16,500 had already been filed against the Johns-Manville Company alone. Costs of these settlements were estimated at $2 billion (44). One insurance company told Congress that anywhere from $40 to $90 billion dollars worth of product liability claims could be forthcoming and these figures do no cover the costs of litigation (2).

Representative Millicent Fenwick (NJ-R), introduced a bill in May, 1979, which would have required the federal government to pay off product liability claims of any U.S. citizen exposed to asbestos prior to December, 1980. Despite strong support from the Johns-Manville lobbyists (their largest plant was in her congressional district), this bill was quickly dropped. She introduced another bill in December of 1981, which combined federal and industry financing for asbestos victims. This bill was similar to one introduced earlier in the year by Senator Gary Hart (COLO-D). Senator Hart's bill called for the establishment of "minimum federal standards for asbestos compensation, with appeals to the federal government if state worker's compensation awards fail to meet those standards" (2).

Both of these bills were dropped, however, and in March of 1982, H 5735 was introduced by Representatives Miller (CA), Perkins (Kent), Williams (Mont), and Fenwick (NJ). This bill was to provide for the "compensation of individuals who are disabled as a result of occupational exposure to asbestos or uranium ore.

and to regulize (sic) the fair, adequate and equitable compensation of certain occupational disease victims" (2). After receiving a hearing in the House, it was dropped as it was considered by many in Congress to be "an expensive new precedent for compensating victims of environmental exposure to toxic substances."(2) Even supporters of existing federal programs for compensation of workers with "black lung" disease cringed at the thought of the repercussions of this bill (2).

By August, 1982, the Johns-Manville Company along with UNARCO (United Asbestos and Rubber Company), and Amatex Corporation were being held liable in several billion dollars worth of product liability lawsuits (25). Therefore, they all filed for bankruptcy under Chapter 11 of the 1978 bankruptcy law, PL 95-598. Under this law all payments to creditors or plaintiffs in asbestos lawsuits were stopped and any new lawsuits brought against these companies were disallowed.

Despite having filed bankruptcy, the Johns-Manville Company still remained financially sound. For the most part, it was business as usual and very few congressmen had much sympathy for the "ailing" multi-million dollar industries (36).

The Johns-Manville Company is still protected under the Chapter 11 bankruptcy law but this past August, the company proposed to set up a trust fund to compensate asbestos workers with half of its stock holdings. The proposal had been approved by the company's top managers, however, existing stockholders could lose up to 80 percent of their equity and management could lose control of the company if the proposal is placed into action

(18). Still, it would provide a much more reliable source of compensation for the asbestos workers. Questions had been raised regarding the purpose of the 1978 Bankruptcy Law when corporations can walk away from their liabilities so easily and several years later devise a scheme to pay off these liabilities. Why is it that they were not required to use these stockholdings in August, 1982, when they filed for bankruptcy?

By the beginning of 1985, the number of lawsuits that had been filed against asbestos companies was staggering. For example, 25,000 lawsuits had been filed against thirty companies by March of 1985 (27). On 11 March, the first "megatrial" was held in a renovated high school auditorium in San Francisco. Renovation alone cost $400,000 (27). California Judge Ira Brown presided over a courtroom of 150 lawyers representing a variety of individuals and firms including Johns-Manville who was suing sixty-five insurance companies for not covering insurance claims. Previously, they had settled with six of their insurers for $427 million (27).

From "magic mineral" to invisible killer to being the cause of billions of dollars in liability suits, asbestos continues to provoke strong concern from congressional officials and the Service Employees International Union, which represents 100,000 school workers (46). Stricter asbestos standards and quality control standards over contractors who are performing asbestos removal are being called for. The EPA performed a survey that indicated that 90 percent of all school districts have complied with their 1982 rule which required them to inspect for and

report findings of asbestos in schools to the workers and parents (46). Critics of this survey say that about half of all school districts have yet to comply with this inspection rule (46). Concern has also been raised about the quality of asbestos clean up efforts.

A report by the General Accounting Office in March, 1985, indicated only about half of all the asbestos abatement work was performed properly and that about 18 percent was inadequately done (32 percent of the cases had no basis for judgement) (46). In 1984, EPA officials estimated that only about 25 percent of asbestos removal contractors were competent in that type of work (46).

These reports have forced Congress to require all schools using federal funds for their asbestos abatement programs to use contractors who are state certified or workers who have received training from the EPA. This requirement was outlined in their fiscal 1986 appropriations bill (HR 3038) which authorized $50 million for the EPA asbestos clean up program and was passed on July 25, 1985 (46).

Action is finally being taken to help the schools clean up the problem. However, it is estimated that almost every building in the United States contains asbestos that has the potential to become friable and is, therefore, potentially hazardous. The EPA had been contemplating action against further asbestos use since 1979, but had only studied the problem until 1983. Finally, in 1984, with the replacement of Anne. M. Burford by William D. Ruckelshaus as administrator of EPA, changes emerged (6). In May,

1984, the EPA sent a plan for review by the Office of Management and Budget (OMB), as it was required to do. This plan proposed the prohibition of all uses of asbestos and the phase out of its existence over the next ten years.

The OMB stopped the asbestos plan because it said the EPA had not discounted the costs of human life when it prepared its cost-benefit analysis. In other words, when the EPA wrote the plan, it figured that $1 million would be saved per cancer case in its ten year phase out program. The OMB said that the $1 million saved should have been economically discounted over those ten years (6). As if to say one could place a value on human life in the first place but the OMB wanted to then discount that life saying that life becomes less valuable over the years! Additionally, the OMB charged that the EPA had no authority to regulate asbestos at all and required that under Chapter 9 of the Toxic Substances Control Act, the EPA should refer the entire asbestos issue to OSHA (6).

These charges prompted a congressional investigation by the Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce which found the OMB guilty of being influenced by the asbestos industry and therefore, entirely out of line in requiring the EPA to refer the asbestos issue to an agency which has authority over the workplace only (41). They were also found guilty of stopping the "ban asbestos" proposal and the subcommittee voiced its "earnest hope that the EPA will now promptly issue proposed regulations to control the risks of ongoing asbestos production, manufacture, and use" (41).

In January, 1986, the EPA proposed an immediate ban on four asbestos-containing products: tile, roofing and flooring felt, cement pipes, and vinyl asbestos floor tile. Protective clothing made with asbestos would also be banned by this proposal. Additionally, the proposal would phase out, over the next ten years, all uses of asbestos as well as the import and American mining of the mineral. Since there is no known substitute for asbestos used when making brake linings, the new proposal does not ban the manufacture of this product. It also does not require the removal of non-friable asbestos insulation from public or private buildings (16). With the passage of this proposed ban the beginning of the end of the asbestos nightmare may come to pass.

NOTE: A listing of the Chronology of Events relevant to the history of asbestos is presented in Appendix A.

EXPERT SYSTEMS

Expert systems are computer programs that process information in a fashion that simulates the thought process and knowledge of a professional expert. Knowledge engineers "capture" the expertise of a professional and translate it into a knowledge base recognizable to the expert system. The system then uses the knowledge base, in conjunction with a reasoning strategy to make decisions or provide advice about a particular subject which would normally be provided by a human expert. The computer programs which process the knowledge bases are also referred to as expert system shells.

The application of the expert system used in this report consists of a decision-making process that considers information that is provided concerning the nature of asbestos containing materials for one or more locations within one or a variety of facilities. The information is then processed in such a way so that recommendations can be made to the owner regarding any corrective action that should be taken. These recommendations include enclosure, encapsulation, or removal of the asbestos-containing material (ACM). Furthermore, the program will establish a Criticality Index for each ACM location so that the facility owner or manager can logically prioritize and remedy the handling of the materials based on the physical condition of the materials. The Insight II+ expert system was chosen to perform this application.

Insight II+ uses a backward-chaining strategy to reach it's conclusions. This means that the program uses answers to specific questions or data, provided by the user, to prove or disprove specific goals or conclusions previously established by the knowledge engineer when writing the knowledge base.

Knowledge is represented in a knowlege base by a language called Production Rule Language or PRL. The language uses IF...THEN...ELSE statements to arrive at it's conclusions. Numeric values as well as facts can be analyzed as supporting conditions for a specific goal or conclusion. Supporting conditions are analyzed as either true or false unless the user is asked to supply a confidence factor for the answer provided.

The confidence factor, if provided, is compared to the confidence threshold established by the knowledge engineer to determine the reliability of the supporting condition. Supporting conditions not matching or exceeding the established threshold of confidence are disregarded and considered to be false.

Insight II+ has the additional capability of accessing an external database for storage of various types of data provided by the user or deducted by the program. Pascal programs must be written to gain access to and send or retrieve information from the database. The accessiblity to a database by the Insight II+ program can be used as an additional method of manipulating, organizing or storing important data. It enhances the power of the Insight II+ expert system.

The most impressive capability of the Insight II+ expert system, along with other expert systems, however, is their ability to make the expertise of a professional available to a much broader range of individuals, at a less expensive price. Individuals who have no knowledge about a particular subject will soon be afforded the opportunity to access new avenues of expertise with the advent of expert systems.

NOTE: Insight II+ software is designed to run on an IBM or IBM-compatible computer with a minimum of two double-sided floppy disk drives, 512K bytes of RAM memory and PC-DOS or MS-DOS version 2.0 or greater.

RESEARCH METHODOLOGY

Insight, Insight II and Insight II+

Research for this report was performed by first learning to use the Insight, Insight II and Insight II+ software and then developing an application amenable to their capabilities. When research for this report began, only the first version of the Insight expert system was available. This version was extremely limited in its capabilities. It could perform no calculations with numbers and required the knowledge engineer to write repetitious IF...THEN statements in order to prove or disprove one goal. It also limited the questions to be asked of the user to 65 characters.

Insight II became available at approximately two months prior to the deadline for this report. It provided a realm of additional capabilities which included number calculation, access to external databases for data storage or manipulation, the ability to write questions for the user which could exceed 65 characters and the ability to cycle through the knowledge base as many times as desired by the user. However, transfer of information to and from external databases was limited to numeric characters only. No verbage or strings of information could be transferred.

Approximately, four weeks after receiving Insight II, Insight II+ was received and although the deadline for this report was drawing near, the additional capabilities of Insight II+ were too useful to forego. Any type of information, strings, boolean, numeric, etc. could be transferred to and from databases. The command allowing the user to cycle through the knowledge base was simplified. To date, Insight II+ has all the requirements needed to determine the Criticality Index of asbestos containing material in several locations and to recommend methods of controlling release of asbestos fibers from the ACM. Knowing the Criticality Index will enable the facility manager or owner to prioritize the critical nature of asbestos containing material.

Learning to Use Insight II+

Familiarity with programming in Basic and Fortran helped to understand the basic methodology of writing this computer program. However, the Production Rule Language used in Insight II+ was confusing to learn at first. The backward-chain reasoning concept required a different type of logic to be used when writing the program as the computer had to be taught to think like a human. It was difficult, at first, to ensure that all supporting conditions for a particular goal had been included in the program. In addition to learning to use Insight II+, the Pascal language had to be learned in order to be able to access a database for data storage or manipulation.

A monumental step in the research methodology for this report was the development of a suitable application for the Insight II+ software. At the time when only the original Insight package was available, a thorough literature review was performed which included reading material written about expert systems and books about artificial intelligence (the computer science concerned with writing software to enable computers to process knowledge much like the human brain). Also, expert systems perfected in the past were run to become more familiar with the practicality of the systems and interviews were held with university professors, familiar with the use of expert systems, to gain a further understanding of how they work.

After gaining a thorough working knowledge of the Insight program, an application was selected which would prioritize the critical nature of asbestos containing material in several locations and recommend methods of controlling the release of asbestos fibers from the ACM. This prioritization required the development of an assessment algorithm based on various conditions of the asbestos. The condition of the ACM once examined would indicate the criticality of controlling the ACM. Subsequently, by comparing the criticality indexes of several ACM locations, prioritization of these locations can be accomplished.

Prior to establishing the assessment conditions, the history, use, lethal effects, regulatory control, legislation, etc., pertaining to asbestos were thoroughly researched. This research required extensive review of an immense collection of information which resulted in a thorough understanding of the

asbestos mineral and the terminology used when referring to the problems it causes.

In order to determine which assessment conditions of the ACM should be utilized, several assessment algorithms developed in the past by the Environmental Protection Agency and several other environmentalists were examined. From these algorithms and through several interviews with asbestos consultants, thirteen assessment conditions were selected to determine the critical nature of the ACM.

A basic program was written to determine what recommendations should be made for controlling a specific location with asbestos containing material. This program was originally written using the original Insight and subsequently updated and expanded as the later versions were received.

Approximately seven months were spent learning Insight, Insight II and Insight II+.

RESULTS

Assessing the Asbestos Containing Material

Thirteen attributes of the asbestos containing material (ACM) are examined in this algorithm to assess the critical nature of the ACM and recommmend methods for its control. These attributes are:

Material Condition (Amc)
Water Damage (Wds)
Exposed Surface Area (Esa)
Accessibility (Aa)
Activity and Movement (Am)
Air Plenum or Direct Air Stream (Ap)
Friability (Fs)
Asbestos Content (Acs)
Roof Type (Rs)
Substrate Type (Sub)
Number of Individuals Exposed (Npe)
Liability Concerns (Ls)
Awareness of Individuals Exposed (Ks)

Material Condition. The material condition is the most important attribute used to indicate the potential for fiber release from the ACM. The overall condition of the ACM is examined to determine the extent of damage to the ACM. One should consider how well the ACM adheres to its substrate, if there has been any water damage or damage due to vandalism to the ACM and how much of the total amount of the ACM has been damaged.(less than or greater than 10%).

Water Damage. Infiltration of water into asbestos containing material can cause the ACM to delaminate and/or break apart as well as dissolve the binder which holds the asbestos fibers together. When the binder in the ACM breaks down the potential for fiber release increases greatly. Water damage can result from roof leaks, plumbing leaks, spills in a laboratory, humidity in the area of a swimming pool or sauna and a variety of other sources.

Water damage discussed in this program is any damage to ACM by any liquid substance that might result in the delamination or breakdown of the binder in the ACM.

Exposed Surface Area. The amount of exposed surface area of the ACM is important to know as exposure of a large area of ACM will increase the likelihood that the ACM may be disturbed and thereby release asbestos fibers into the atmosphere. ACM is considered visible if it can be seen by building occupants without removing any physical barrier such as suspended ceiling tiles.

Accessibility. The accessibility of building occupants to the ACM directly relates to the potential of someone deliberately or accidentally rubbing against or contacting the ACM and causing

asbestos fibers to be released. Increased accessibility increases the likelihood that the ACM will be contacted and fibers will be released into the atmosphere.

Activity and Movement. Disturbance of ACM directly relates to the amount of activity and movement that takes place in the vicinity of the ACM. When considering activity, the movement of people as well as any vibrations or high levels of noise must be taken into account. Vibrations or loud noise may be evident in areas such as a band room, machinery room, or rooms located near a highway.

Air Plenum or Direct Air Stream. This is another very important attribute that must be taken into consideration when determining methods of asbestos control. The presence of an air plenum or direct air stream increases the possibility of asbestos fibers becoming airborne or being distributed to other areas of the building. When this happens, a greater number of individuals become exposed to the fatal fibers.

The presence of supply outlets creates a greater risk in a room containing ACM as the asbestos fibers, if present, will become airborne and the susceptiblity of the room occupants to breathe the fibers is tremendously increased.

Friability. Friability is another very important attribute to be examined. Friable means that the ACM can be crushed or pulverized by hand pressure. There are varying degrees of friability. The more friable the material, the more susceptible it is to releasing fibers into the air. Spray applied ACM is generally more friable than trowel applied material.

Asbestos Content. In this assessment algorithm, the asbestos content (by percentage) may be determined by a laboratory analysis or may be estimated by the user. Trace amounts of asbestos (<1%) are generally disregarded. Amounts greater than one percent have a much greater potential for asbestos fiber release.

This attribute is used to differentiate between situations that may be identical in nature for the other attributes.

Roof Type. The type of roof on a building containing ACM must be taken into consideration when assessing the potential for damage to the ACM. A building with a flat roof will tend to hold more water. Additionally, an older or built-up roof has a greater potential for leaking. The water may eventually find its way to the ACM and cause the ACM binder to break down.

Substrate Type. Substrate type is only considered if the ACM has been sprayed onto it's substrate. ACM sprayed onto steel or wire mesh will release fibers into the atmosphere more readily than ACM sprayed onto a tightly bound scratch or brown coat or concrete.

Number of Individuals Exposed. The requirement to control the ACM becomes more critical as the number of individuals exposed or potentially exposed to the ACM increases. For instance, say the

ACM is in a storage closet that is only accessed by one or two janitors. This situation is less critical than if the ACM were located in a classroom with a capacity to hold up to fifty individuals.

Liability Concerns. ACM accessible or visible to the public can damage the reputation of a firm or institution if significant action is not taken to control it. The increased awareness of the public on the fatal affects of asbestos makes its presence a very sensitive liability issue and thereby increases a firm's responsibility to take measures to control the ACM.

Awareness of Individuals Exposed. When assessing the critical nature of an ACM, it must be determined how aware the individuals, that will or may come in contact with the ACM, are that the ACM contains asbestos and should not be touched or disturbed. Most employees may understand that a specific location of ACM is asbestos and should not be touched, however, individuals that do not normally occupy the building would be unaware of the situation and it, therefore, presents a more critical problem.

Recommendations to the Facility Owner or Manager

After assessing the critical nature of the asbestos containing material, a Criticality Index is calculated and assigned to the particular location housing the ACM. This Criticality Index is then used to determine the appropriate method for controlling the release of asbestos fibers in the future and to prioritize one or more locations of ACM.

Encapsulation. If the criticality index calculated is greater than or equal to zero or less than thirty, encapsulation is the recommended method of control. The potential for asbestos fiber release is not very great and the risk of fiber release can be lowered by encapsulating the ACM. Encapsulation is not recommended, however, regardless of the value of the criticality index, if the ACM has been damaged by water, if the ACM is highly accessible or if the ACM is friable.

Enclosure. Enclosure, although it is not a very common method of controlling ACM, is recommended for locations whose criticality index is equal or greater to thirty and less than sixty. Enclosure reduces the accessiblity of the ACM to building occupants, however, if voids are present in the joints or seams of the enclosure, asbestos fibers may be released through them. For this reason, enclosure might be used in conjunction with encapsulation.

Like encapsulation, enclosure is not recommended if the ACM has been damaged by water, if the ACM is highly accessible or if the ACM is friable.

Removal. Removal is the most complete control method that can be recommended. It is recommended in those cases where the criticality index is greater than sixty. It will ensure complete eradication of the ACM. However, if the removal of the ACM is not performed properly, it can increase asbestos fiber level in the atmosphere of the location from which it is being removed, as well as in the atmosphere of surrounding rooms or buildings.

The recommendations outlined above must also be tendered with such constraints as provided by common sense, budgetary limitations, and pressure from employees or the public sector. Encapsulation, although recommended, may not be desirable as a control method as there may be no type of sealant available on the market that will be absorbed by the ACM. The ACM may be too thick to be fully penetrated by the sealant. Additionally, some encapsulants must be reapplied periodically and the additional maintenance this creates may not be desirable to a facility manager. Something else to consider is that any ACM that is removed must also be replaced by a non-asbestos material. This fact raises the cost of the already expensive removal operation.

Use of INSIGHT II+

INSIGHT II+ is an expert system shell that will run the knowledge base 'Priasbes' which calculates the Criticality Index (CI) for one or several locations containing ACM. This Criticality Index can be used by the facility manager to compare locations of ACM and determine which location is more critical and should be remedied first. Additionally, using the Criticality Index, the 'Priasbes' knowledge base will determine recommendations for controlling the asbestos fiber release from the ACM.

'Priasbes' queries the user about the condition of the ACM through questions which pertain to the various attributes outlined above. Each attribute is assigned a numerical value based on the extent of damage to the ACM, the accessibility of the ACM by the public, or the potential for fiber release from the ACM.

Once a value has been assigned to all attributes, the Criticality Index is calculated using the following formula:

$$CI = (Amc+Wds+Esa+Aa+Am+Ap+Npe+Ls+Ks+Rs+Sub) * (Fs*Acs)$$

This formula is a modified version of the formula derived by the Environmental Protection Agency (47).

Upon calculation of the Criticality Index (CI) for a particular location of ACM, a recommendation can be made for controlling asbestos fiber release from the ACM. Recommendations are based upon the following Corrective Action Scale:

Criticality Index Range	Recommendation
0 - 30	Encapsulation
30 - 59	Enclosure
greater than 60	Removal

Additionally, the 'Priasbes' knowledge base examines closely the water damage to the ACM, the accessibility of the ACM and the friability of the ACM. If the ACM is water damaged, highly accessible or friable, neither encapsulation nor enclosure will be recommended regardless of the Criticality Index value. Removal will then be recommended in these situations.

Once a recommendation is made by the knowledge base, a report is displayed on the screen outlining the ACM location and recommendations of corrective action for that location. This same report is sent to the printer so that a hard copy may be retained by the user. The computer then asks the user if another asessment is to be performed. As long as the answer is yes, the procedure outlined above is repeated.

When the user is finished using the 'Priasbes' knowledge base, the Criticality Indexes assigned to each ACM location can be compared to determine which locations are the most critical and should, therefore, be considered for appropriate action first.

While the knowledge base is being run, it is concurrently storing information about each ACM location in an external file named 'Form'. Once the user is finished using the 'Priasbes' knowledge base, the INSIGHT II+ program can be exited and the file 'Form' can be accessed to print out its contents. The building number, room number, location description and Criticality Index of each ACM location examined can be printed out in report format.

PRIASBES USER DOCUMENTATION

THE PRIASBES KNOWLEDGE BASE.

PRIASBES is a knowledge base designed to run on the INSIGHT II+ expert system shell developed by Level Five Research of Melbourne, Florida. The knowledge base was developed to allow facility managers to prioritize the critical nature of several locations containing asbestos containing material (ACM). Additionally, the program will recommend control measures to be taken to ensure the ACM does not release fatal asbestos fibers into the air.

COMPUTER FEATURES REQUIRED.

The user of PRIASBES must have the program disk, Disk A, for the INSIGHT II+ software and a second disk labeled "Disk B - PRIASBES Knowledge Base" in order to run PRIASBES. The disks should contain the following files:

DISK A:

READ.ME	I2.004
I2.COM	I2.005
I2.000	I2.USR
I2.001	C.USR
I2.002	HARDDISK.BAT
I2.003	HD2.BAT

DISK B: (as a minimum)

I2EDD.COM	PRIASBES.PRL
I2EDD.000	PRIASBES.KNB
I2.MSG	PRIS1.PRL
I2.HLP	
DBPAS.COM	

INSIGHT II+ can only be run on an IBM or an IBM compatible computer with a minimum of two double-density floppy disk drives, 512K bytes of random access memory (RAM) and at least a 2.0 version of PC-DOS or MS-DOS. To run PRIASBES on INSIGHT II+ the user must have 512K bytes of RAM. A printer is also a necessary accessory.

FAMILIARITY REQUIRED OF USER.

The user of PRIASBES must be basically familiar with the use of a microcomputer and have used one at least several times in the past. Familiarity with simple DOS commands will prove helpful but not a necessity. The user must be able to start the computer and get the DOS prompt "A>" on the screen. It is also essential to be able to check the directory on a floppy disk to ensure that the files listed above are on the floppy disks to be used.

HOW TO USE PRIASBES WITH INSIGHT II+

LOADING THE DISKS ONTO THE COMPUTER.

1. After turning the computer on and booting it, and with the DOS prompt "A>" on the screen, insert the Disk A program disk in the 'A' drive and insert Disk B in the 'B' drive.

2. To run the INSIGHT II+ program, at the "A>" prompt type:

A>I2

3. After the title page of INSIGHT II+ appears on the screen, you will be presented with a menu of all the major functions of INSIGHT II+ that are available:

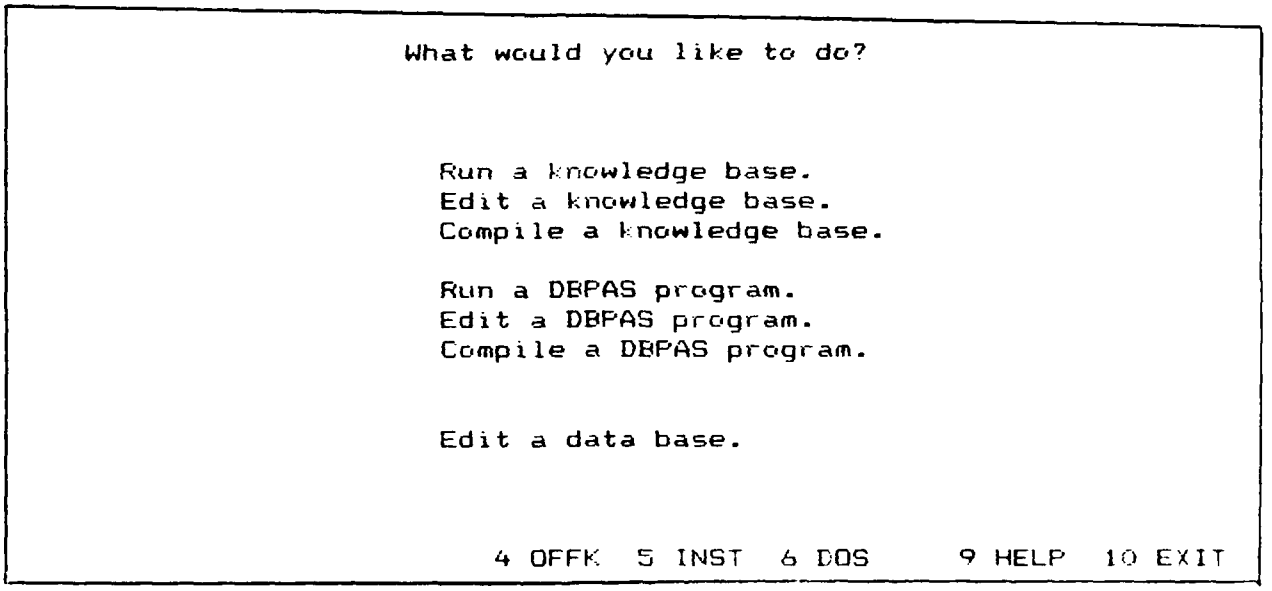

Figure 1. INSIGHT II+ Feature Menu

Also available for use are function keys on the left side of the keyboard labeled F1 - F10. The functions of these keys are identified at the bottom of the screen in highlighted boxes.

For instance, on the screen shown above the function key F9, if pressed, would provide you with HELP or the F10 key would permit you to exit the INSIGHT II+ program. If you desire to try these keys hit F10 and you will be asked if you really want to exit the program. If you want to exit the program, press F1, and you will be returned to the DOS prompt "A>". You will then have to follow the directions above to return to the program once again. If you do not want to exit, press F8 and you will return to the feature menu once again.

CALLING UP THE PRIASBES PROGRAM.

1. With the feature menu on the screen, position the cursor arrow beside the feature titled "Run a Knowledge Base" and press the return key.

. The screen will ask you to select a knowledge base to run from those available on the screen. There will only be one knowledge base available to you at this time: the PRIASBES Knowledge Base. With the arrow in front of the file 'PRIASBES', press the return key.

RUNNING THE PRIASBES PROGRAM.

1. The title page for the 'PRIASBES' Knowledge Base will appear on the screen as shown in Figure 2.

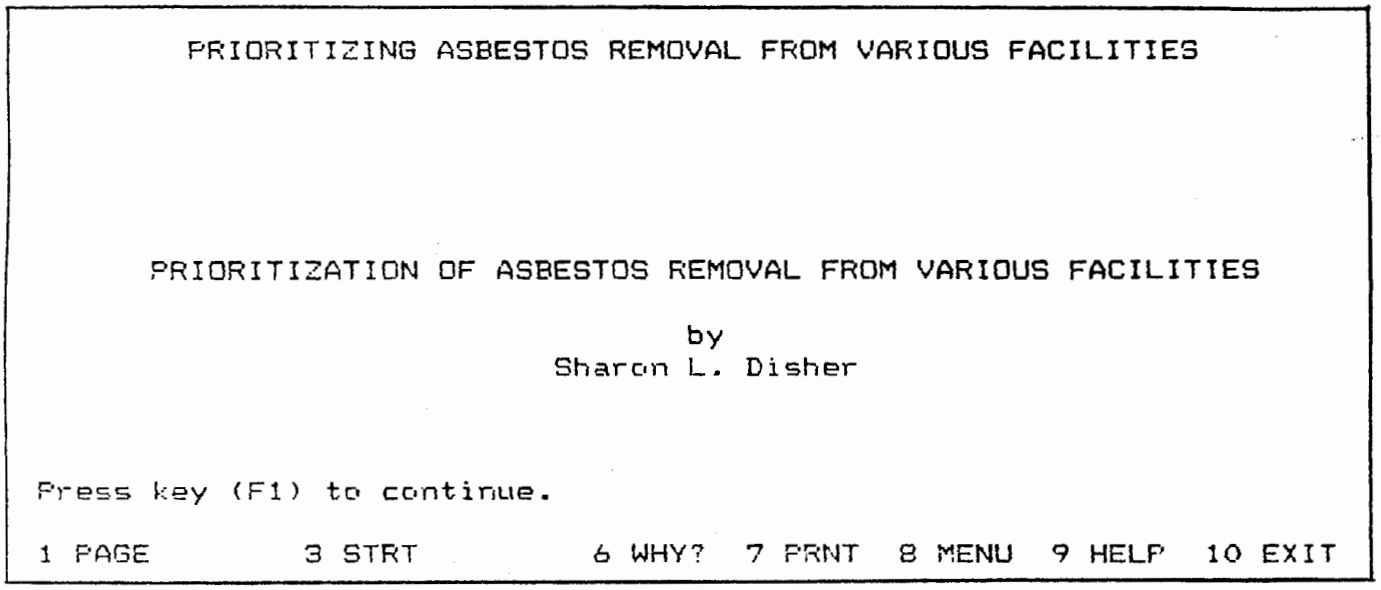

Figure 2. Priasbes Title Page

After reading the title page and subsequent pages simply follow the instructions presented on the screen to make your way through the program, ie. press key F1 to continue. These instructions will be available to you throughout the use of the PRIASBES Knowledge Base. If no specific instructions are outlined on the screen, you are merely required to press the return key once you have selected or input your answers.

Additionally, an example is provided in the appendix for your use in becoming familiar with using the 'Priasbes' knowledge base.

3. Once you have finished inputting information for a specific location, you will be asked if you want to perform another

assessment for another location. If you do, enter "True", and if you do not, enter "False" and the message "END OF SESSION" will appear on the screen.

4. Once you have completed assessing all of the ACM locations, you may make a printed report of all locations just examined by pressing key F10 and then F1 to exit the INSIGHT II+ program. When the A> prompt appears on the screen, type:

A> PRINT Form (press return)

A hardcopy of the following should be printed out:

A REPORT OF ACM LOCATIONS

BUILDING NUMBER ROOM NUMBER LOCATION DESCRIPTION CRITICALITY INDEX

(the information you just input should appear here in the appropriate column)

5. IF YOU MAKE A MISTAKE

While running the program, if you inadvertently enter information that is incorrect, you may correct it if you have not pressed the return key. By using, the backspace key or delete key, you can erase what you may have typed and retype your answer. By using the arrow keys, you can move the arrow to the proper answer for those answers that are already displayed on the screen.

However, if you have entered an answer by hitting the return key, the answer is locked in and you must restart the program to change it. Therefore, it is very important that you ensure the answer shown on the keyboard is the correct answer before pressing return.

6. NOTES ON PRIASBES

There are some features of the INSIGHT II+ expert system used in the knowledge base 'Priasbes' that are easier to explain by means of examples. Therefore, please refer to Appendix B, Example Problem, or further explanations on the use of PRIASBES before running the knowledge base for your own use.

A copy of the 'Priasbes' Knowledge Base is listed in Appendix C.

SUMMARY

The INSIGHT II+ expert system, in conjunction with the 'Priasbes' knowledge base, can be used to assist a facility manager or owner to determine what actions should be taken to ensure that no fatal asbestos fibers are released from asbestos containing materials (ACM) existing in various facilities. More than one ACM location may be examined and prioritization of these locations may be performed by comparing the Criticality Indexes of the various locations.

The prioritization system is based upon thirteen conditions or factors which evaluate the potential of the asbestos containing material to release fibers into the atmosphere and ultimately determine its Criticality Index. The Criticality Index is a numerical value which rates the potential for asbestos fiber release. It is compared to the Corrective Action Scale to determine the control method which must be undertaken in order to control the asbestos, ie. enclosure, encapsulation or removal.

The thirteen factors or conditions which are evaluated are as follows:

Material Condition

Water Damage

Exposed Surface Area

Accessibility

Activity and Movement

Air Plenum or Direct Air Stream

Friability

Asbestos Content

Roof Type

Substrate Type (if material is sprayed on)

Number of Individuals Exposed

Liability Concerns

Awareness of Individuals Exposed

By using INSIGHT II+ and the 'Priasbes' knowledge base, knowledge normally available to environmentalists or asbestos consultants becomes available to facility managers or owners in a form that is easy to use and is readily available. Additionally, it provides a consistent method for analyzing the potential for fiber release of a few or many asbestos containing material locations.

RECOMMENDATIONS

Facility managers today, have many demands placed on their time. Therefore, they should take advantage of any new technology developed that may increase their work efficiency or expediency. One of the demands on a facility manager's time is the problem of controlling asbestos. This problem is becoming more important as the regulations for asbestos control become more stringent and the public awareness of the fatal affects of asbestos is increased. Once asbestos containing material (ACM) is identified, the means of maintaining the asbestos material so that it does not release fatal asbestos fibers into the air must then be determined. Additionally, if there exists a number of locations with asbestos containing material, it must be determined which of these locations is more critical and must, therefore, be controlled first.

By using the Insight II+ expert system, in conjunction with the 'Priasbes' Knowledge Base, a facility manager can utilize the expertise of an asbestos consultant without the time-consuming hassles of setting up an appointment with an actual consultant. Additionally, the price for the expert system consultation session will inevitably be less expensive. The 'Priasbes' Knowledge Base will examine any number of asbestos containing material locations and recommend control procedures to ensure the material does not release fatal asbestos fibers into the atmosphere. Additionally, this knowledge base will assign a Criticality Index to each

location in order that the facility manager may prioritize two or more locations.

In fact, with a fair amount of training, the asbestos inspectors or those individuals that performed the asbestos survey can be trained to use the Insight II+ expert system. The task of running each ACM location through the 'Priasbes' Knowledge Base could be delegated to that individual, thereby, freeing up more of the facility manager's time.

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APPENDICES

APPENDIX A

THE ASBESTOS NIGHTMARE

CHRONOLOGY OF EVENTS

STONE AGE	Asbestos used by cavemen to make pottery.
436 B.C.	Greek sculptor Callimachus used asbestos wick in lamp made for Temple of Pallas Athene.
1 A.D	"Sickness of the lungs" in slaves who weaved asbestos cloth noted by the Greek geographer Strabo and Roman naturalist Pliny the Elder.
79 A.D.	Pieces of asbestos cloth used as funeral dress for kings in Pompeii.
1250 A.D.	Marco Polo became enthralled with fire resistant cloth made from asbestos.
1866	Signor Albonico of Rome made "first" asbestos cloth.
1879	Worlds first commercial asbestos mine opened at Thetford in Quebec, Canada - 300 Tons asbestos produced.

1898	Henry Ward Johns, founder of Johns Corp., later to become Johns-Manville Corp. died from chronic lung condition - asbestosis?
1900	Autopsy performed on 33 year old asbestos factory worker by Dr. H. Montague Murray of London's Charing Cross Hospital. First time connection drawn in "modern times" between asbestos exposure and fatal respiratory disease.
1902	Johns-Manville Corporation founded.
1910	Bell's United Asbestos Company formed as one of the largest manufacturers of asbestos - 30,000 tons produced annually worldwide.
1912	Largest Johns-Manville plant opened in Somerset County, New Jersey.
1924 July	First clear case of death due to asbestos published in British Medical Journal by Dr William E. Cooke.
1930	State governments of Iowa, Illinois, California, Wisconsin and Connecticut officially recognized asbestos as a disease producing material.

1927-1931 Range of medical studies performed in Great Britain linking asbestos with fatal lung diseases.

1931 British Parliament, reacting to the results of medical research, made asbestosis a compensable disease for workers in the field. Improved methods of dust suppression and exhaust ventilation were required in textile factories and periodical examinations of asbestos textile workers were required.

1935 Dr. Kenneth M. Lynch, Professor of Pathology at the Medical University of South Carolina, published first case of asbestos being related to cancer.

500,000 tons asbestos produced annually worldwide.

New York, Pennsylvania, Indiana, Maryland and Washington state enacted laws to warn workers of the health hazards of asbestos and provide workmans compensation for those workers contracting asbestosis.

1936 National magazine "Asbestos" published by the Johns-Manville Corp. began to propogate information on the utility of asbestos products without warning the public of its known fatal properties.

1940 Asbestos began to be used in school construction. Asbestos was commonly sprayed on building components for fireproofing, sound attenuation or decoration.

1943 Navy Department and U.S. Maritime Commission published booklet "Minimum Requirements for Safety and Industrial Health in Contract Shipyards" which warned workers that asbestosis could be contracted from any "job in which asbestos is breathed".

1946 State, federal and local governments changed their building codes to require the use of asbestos construction materials.

1947 Dr. E.R.A. Merewether published his Annual Report as the Chief Inspector of Factories for the Year 1947 on "Asbestos and Carcinoma of the Lung".

1949 Johns-Manville Corp. employed private physician to survey the workers of their Canadian asbestos mines. Results reported a significant number of lung mutations were kept confidential and remained unpublished.

1955 Dr. Richard Doll, Director of Statistical Research Unit of the British Medical Research Council after studying over 113 autopsies of asbestos workers drew a definite link between asbestos exposure and lung cancer. A causal relationship from then on was recognized by the medical profession. Industry was not convinced, however.

1959 3/4 million tons asbestos produced annually worldwide.

1960 3 million tons asbestos produced annually worldwide.

1962 Dr. Irving J. Selikoff, Head of Environmental Medicine at Mount Sinai School of Medicine, opened informal clinics around New York City in union halls and tested workers of 2 local asbestos unions.

1964 New York Academy of Science sponsored the International Conference on the Biological Effects of Asbestos in New York City.

Dr. Irving J. Selikoff published his study in the Journal of American Medical Association which furnished the first incontrovertible evidence that industrial exposure to asbestos was potentially fatal. Additionally, he established sound methodology for future studies and linked the effect of cigarette smoking with asbestos to increase the chances of cancer.

Johns-Manville Corp. began putting cautionary labels on it products.

1968 4 million tons asbestos produced annually worldwide with over 3000 industrial applications in the U.S. alone.

1970 January President Nixon signed the National Environmental Policy Act of 1969 into law 91-190.

December William-Steiger Act signed into law more commonly known as the Occupational Safety and Health Act. This called for the establishment of the

Occupational Safety and Health Administration (OSHA) and the National Institute for Occupation Safety and Health (NIOSH).

OSHA imposed first voluntary standards on industry for limiting occupational exposure to asbestos.

1971 May — OSHA set first numerical standard limiting worker exposure to asbestos to 12 fibers per cubic centimeter.

October — Asbestos added to EPA and NESHAP's list of atmospheric pollutants. National Research Councils Committee on Biological Effects of Atmospheric Pollutants recommended controls be placed on asbestos emissions into the atmosphere.

December — AFL-CIO placed pressure on OSHA to increase standards limiting workers exposure to asbestos. Emergency standard of 5 fibers per cubic centimeter set by OSHA.

1972 June — OSHA reduced "permanent standard" for occupational exposure to asbestos from 5 fibers per cubic centimeter (5 f/cc) to 2 f/cc to be

accomplished in all asbestos work areas by July 1976. This exposure standard was published in the Federal Register.

New York City Council banned all spray applications of asbestos per Local Law 1971, Air Pollution Control Code.

1973 January — Borel Lawsuit against 11 asbestos manufacturers became first asbestos case to go to jury. Case won by Borel widow whose husband died from severe case of asbestosis and mesothelioma after working in asbestos factory for over 30 years and having never been warned of the dangers of asbestos.

April — EPA and NESHAP announced the National Emission Standard for Asbestos which stated that no visible emissions of asbestos would be allowed when milling or manufacturing asbestos or when demolishing buildings containing asbestos.

April — EPA prohibited sprayed application for most uses of friable asbestos materials containing more than 1% asbestos. This did not apply to decorative uses.

1975	March	FDA announced rule to prevent release of asbestos fibers from filters used for some drugs.
	October	OSHA recommended lowering the "permanent standard" to 0.5 f/cc.
	October	EPA included waste collection and disposal under "no visible emission "standard.
1976	March	MSHA (Mine Safety and Health Administration) set 2 f/cc standard in coal mines.
	July	OSHA's 2 f/cc standard went into effect.
	December	NIOSH recommended OSHA lower standard to 0.1 f/cc.
1977		Clean Air Act Amendments of Bill HR 6161 passed and signed into PL 95-95. Law's fundamental purpose was to protect public health by cleaning the air. New air quality standards set were to be met by all U.S. cities by 1982. This amended the Clean Air Act of 1970.

	December	CPSC (Consumer Product Safety Commission) announced rule prohibiting use of asbestos in consumer patching compounds and emberizing agents.
1978	June	EPA and NESHAP extended prohibition to cover all uses of friable sprayed on asbestos material and "no visible emissions" standard to cover all friable asbestos-containing materials during demolition.
	July	American Cancer Society study of 92 asbestos factory workers exposed to heavy doses of asbestos dust for one month showed slight to doubling increase in asbestos related disease and lung cancer 5 to 35 years after exposure.
	August	Hand-held hair dryers was publicized as containing asbestos linings - 13 million of these dryers believed to be in use in American households. Televison station tried to get interest of Consumer Product Safety Commission. CPSC determined this asbestos problem not serious based on $20,000 study by a management consultant firm that asbestos is no longer used in the manufacture of hair dryers.

1978 International Asbestos Information Association declined to recommend warning label be required on all asbestos products shipped to specific countries for fear of possible drop in sales.

13 July Bill H 13461 introduced by Congressman Richmond (NY-D), to provide federal assistance to screen workers (and their families) exposed to asbestos who can not otherwise receive screening under worker's compensation, health insurance, or other programs. Referred to Education and Labor committee and dropped.

October U.S. House of Representatives Subcommittee on Compensation, Health and Safety of the Committee on Education and Labor held hearings on "Asbestos Related Occupational Diseases", San Francisco, California.

Secretary of U.S. Health, Education and Welfare Department, Joseph Califano, issued emergency warning about the "immediate, serious health threats" posed by asbestos fibers that become airborne.

1979 March — T.V. station did own research concerning asbestos use in hand-held hair dryers and broadcast results thereby alerting public of asbestos threat.

March — Environmental Defense Fund (EDF), a Washington D.C. based group, backed by the National Education Association, the American Federation of Teachers, and the National Parent-Teacher Association claimed millions of children were being exposed to asbestos in their schools. They petitioned the EPA to inspect 87,000 public schools across nation for asbestos.

April — EPA alerted State officials of the potential high levels of asbestos in schools and initiated a technical assistance program to help schools identify and control friable asbestos-containing materials.

May — CSPC announced it will approve voluntary corrective action proposals of the 11 major manufacturers of hand-held hair dryers. Most hair dryers recalled.

May — Bill before House Subcommittee on Labor Standards introduced by Rep. Millicent Fenwick (R-NJ), required Federal government to pay off product liability claims of any U.S.citizen exposed to asbestos prior to December 1980. Bill supported by Johns-Manville Corp. whose largest plant was in New Jersey. Bill was dropped.

May — Bill HR 3282 approved by House Education and Labor Committee in their report H Rept 96-197. Bill called for new $330 million program to help schools find and remove hazardous asbestos. Committee rejected proposal to assess asbestos industry up to $30 million as its share of problem in an effort to get bill passed as issue was too controversial.

August — Department of Health Education and Welfare announced asbestos is a carcinogen.

August — Department of Transportation announced rule to require controls during transportation of friable asbestos.

October — EPA and CSPC announced intent to consider regulating commercial uses of asbestos.

13 December — HR 3282 passed by House of Representatives but did not reach Senate floor in 1979.

1980 March — U.S. Senate Subcommittee on Education, Arts and Humanities of the Committee on Labor and Human Resources held hearing on "Asbestos School Hazard Detection and Control Act of 1980", New York City.

15 May — Senate passed bill S 1658 after Senate Labor and Human Resources Committee issued their report S Rept 96 -710 that school systems should be eligible for federal aid up to $172.5 million for finding and removing asbestos from schools. This was a watered down version of House bill H 3282.

14 June — House and Senate bills H 3282 and S 1658 signed into Public Law 96-270 "Asbestos School Hazard Detection and Control Act of 1980". Law authorized $22.5 million in FY81 and FY82 for grants to states and local education agencies to find asbestos in school buildings. Also authorized $75 million each in FY 81 and 82 for interest free loans to local education agencies for containment or removal of the asbestos fibers.

August — U.S. Senate Committee on Labor and Human Resources hearings held on "Asbestos Health Hazards Compensation Act".

September — EPA proposed rule to require reporting of production and exposure data on asbestos. Also proposed rule requiring all public and private elementary and secondary school to identify friable asbestos in their buildings by June 1983.

1981 January — No funds appropriated by Congress to conduct Asbestos School Hazard Detection and Control Program PL 96-270.

21 September — U.S. Department of Justice, The Attorney Generals's Asbestos Liability Report to Congress published advising public right to sue asbestos manufacturers, distributors, architects and contractors to recover costs of asbestos removal from buildings.

1982 January — Estimated 17,000 lawsuits concerning asbestos filed against one U.S. manufacturer.

4 March	HR 5735 introduced by Congressman George Miller (CA) et al. which provided for the compensation of individuals who are disabled as a result of occupational exposure to asbestos or uranium ore, and to regulate the fair, adequate and equitable compensation of certain occupational disease victims. Received hearing in the House and then was dropped.
Mar-Apr	Subcommittee on Labor Standards of the Committee on Education and Labor of the U.S. House of Representatives held hearing on "Occupational Health Hazards Compensation Act of 1982", Washington D.C.
July	EPA issued rules requiring schools to inspect for asbestos and report findings of asbestos to parents and employees under the Toxic Substances Control Act of 1976 (PL 94-469).
26 August	Johns-Manville Corporation, UNARCO (United Asbestos and Rubber Company) and Amatex Corp., major manufacturers of asbestos, filed for protection against product liability suits under Chapter 11 bankruptcy policy.

1983 March — EPA issued urgent warning to public and published Guidance for Controlling Friable Asbestos-Containing Materials in Buildings.

November — OSHA issued emergency temporary standard (ETS) of 0.5 f/cc. ETS stayed pending legal arguments by asbestos industry.

1984 March — Emergency temporary standard overturned in Federal District Court.

May — EPA sent proposal to Office of Management and Budget (OMB) to ban asbestos entirely and phase out its use over next ten years .

25 July — HR 1310, Math-Science Bill Amendment, passed by House and Senate authorizing transfer of asbestos program from the Department of Education to the EPA. Also authorized funding for the EPA to aid in removing asbestos from school buildings: $50 million each during FY84 and FY85 and $100 million each for the next five years for grants for 20 year interest-free loans to remove asbestos.

11 August — HR 1310 signed becoming PL 98-377 and authorized changes listed above.

1985 March — 25,000 lawsuits filed against 30 asbestos manufacturers heard in San Francisco's Nourse Auditorium.

April — Congressional Investigating Committee found OMB guilty of stopping the EPA's May 1984 proposal to completely eliminate asbestos.

1986 January — EPA announced its Asbestos Elimination Policy which banned all uses of asbestos and included a ten year plan to phase out all traces of asbestos.

APPENDIX B

APPENDIX B

EXAMPLE PROBLEM:

Swimming Pool, Building 65 Room 101

In the above photograph, asbestos containing material (ACM) has been sprayed on the ceiling of a building housing a swimming pool. We want to determine how critical it is to control this ACM and also to obtain some recommendations as to how to control the ACM. Therefore, we will use the INSIGHT II+ expert system and the 'Priasbes' knowledge base to help us.

1. System Startup.

A. Turn on your computer and printer and boot up the system. Put Disk A in 'A' drive and Disk B in the 'B' drive.
At the DOS prompt "A>" type I2.

B. The title page for the INSIGHT II+ Expert System will appear on the screen and then the feature menu will be displayed. With the arrow next to "Run a Knowledge Base" command, press return.

C. The Priasbes Knowledge Base title page will appear on the screen. Read it and then press key F1 to continue as directed by the screen.

D. Another page of information will be presented for you to read and then key F1 should be pressed to continue once again.

E. After reading the third page of information, press key F3 to continue.

2. Inputting Information.

A. The screen will ask you to enter the building number. Enter '65' and press return. NOTE: *no* alpha numeric characters may be entered, such as 65A, so you must use some other designation such as 65.1. No punctuation marks other than a period may be used.

B. The room number will then be asked of you. Enter '101'. Again, no alpha numeric characters may be entered.

C. From here on, the actual questions that will appear on the screen will be presented to you. Enter the answer as directed.

1.Briefly describe the location of the asbestos containing material:
(in 35 characters or less) (Press return key when done)

ENTER: SWIMMING POOL CEILING

2.Input which location this is (e.g., it is the first location being looked at, input 1, if the second, input 2, etc.)

Since this is the first location we are looking at:
ENTER: 1

3.A narrative about the Asbestos Containing Material Condition will now be presented on the screen. Read it and press key F2 to continue as directed by the screen.2

4.Material is intact and shows no signs of delamination, cracking or deterioration.

ENTER: FALSE

5.The asbestos containing material appears to be intact in most areas, however, pieces smaller than a half-dollar have been dislodged and may or may not have fallen to the floor.

ENTER: TRUE

6.Another narrative about Water Damage is presented for you to read. After reading it, press key F2 to continue.

7.There are no water stains in the vicinity of the asbestos and there is no evidence of material being disturbed by water.

ENTER: FALSE

8.Water has damaged:

less than 10% of the total amount of ACM.

greater than 10% of the total amount of ACM.

ENTER: Using arrow keys on the right side of the keyboard, move the arrow down to greater than 10% and press return.

9.Some of the asbestos containing material (ACM) has been dislodged by water.

ENTER: TRUE

10.The ACM has started to break loose or is saturated with water to the point that it may break loose or fall.

ENTER: TRUE

11.Water infiltration has carried fibers to anothter location or surface in the room and those fibers will be released into the air once the water evaporates.

ENTER: FALSE

12.Narrative appears about the Exposed Surface Area. Read and press key F2 to continue.

13.The asbestos containing material is not visible without removing some physical barrier such as suspended ceiling acoustical tiles.

ENTER: FALSE

14.The asbestos containing material (ACM) visible to building occupants is:

10% or less of the total amount of ACM.

greater than 10% of the total amount of ACM.

ENTER: greater than 10% of the total amount of ACM.

15.The asbestos containing material (ACM) is in a space above a suspended ceiling and this space is used as an air plenum.

ENTER: FALSE

16.Narrative concerning Accessibility to ACM. Read. Press F2.

17.Access to the material is extremely limited. For instance, the ACM might be concealed above a tight suspended ceiling or behind ductwork or piping.

ENTER: FALSE

18.Building occupants can not come in contact with or throw objects (such as basketballs or pencils) at the asbestos containing material (ACM).

ENTER: FALSE (because water could balls occasionally fall the ceiling)

19.The asbestos containing material (ACM) is rarely accessible. Most often the area containg the ACM is vacant of people.

ENTER: FALSE

20.ACM is usually only contacted when infrequent maintenance or repairs are performed.

ENTER: FALSE

21.The ACM is rarely touched by building occupants and rarely are objects thrown at it.

ENTER: TRUE

22.Narrative on Activity and Movement. Read. Press key F2.

23.The asbestos containing area is:

a quiet admin office

in a library

a quiet classroom

a quiet private office

a study hall

an electrical closet

a telephone equipment closet

ENTER: At this point there are three pages of location types from which to select. To view them all before choosing, press key F1 and the next page will appear. Continue pressing key F1 until the page which holds your location is on the screen. In this case, swimming pool is on the second page. With that page on the screen and using the arrow keys, move the arrow to 'in a swimming pool' and press return.

24.The asbestos containing material (ACM) is in an area where activities take place that cause vibrations which may have the potential of releasing asbestos fibers from the ACM. Such activities include playing musical instruments, starting up or shutting down large machines, running noisy machinery, singing or shouting loudly, stamping feet, etc.

ENTER: TRUE

25.There are high levels of activity and movement in the area or room containing the asbestos containing material (ACM).

ENTER: TRUE

26.Occupants of the area create high noise levels.

ENTER: TRUE

27.Occupants of the area are disruptive, destructive or vandalous when performing their activities.

ENTER: FALSE

28.The asbestos containing material is wrapped aroung components such as pipes or ducts that vibrate or move.

ENTER: FALSE

29.There are machines or personnel with equipment in the area that may bump into the AMC and knock it loose, e.g., forklifts or small carts or trolleys.

ENTER: FALSE

30.Narrative on Air Plenums. Read. Enter F2.

31.No air plenum, air vents or outlets exist in the asbestos containing area.

ENTER: TRUE (assume there are none as you can not really tell from the picture)

32.There is no area above a suspended ceiling being utilized as an air plenum.

ENTER: TRUE

33.There is no direct air stream present in the room.

ENTER: FALSE (a direct air stream exists from the bay windows to the outside)

34.Air is being supplied to the room through supply vents or ducts.

ENTER: FALSE

35-36. Do not exist.

37.Narrative on Friablility of ACM. Read. Enter F2.

38.Asbestos containing material is:
(Select one)

hard and can not be damaged by hand pressure. Sharp tools are required to penetrate the material.

difficult to damage by hand pressure

easy to dislodge, crush or pulverize

fluffy, spongy, or flaking

ENTER: Move arrow to 'easy to dislodge, crush or pulverize' and press return

39.The asbestos containing material may be removed in small or large pieces, is soft and can be damaged by hand pressure.

ENTER: TRUE

40.Rubbing the ACM leaves a powder residue on the hand.

ENTER: FALSE (assume it leaves granules)

41.Narrative on Asbestos Content. Read and enter F2.

42.The asbestos content:

was determined by a lab analysis

is being approximated by the user

ENTER: "is being approximated by the user"

43.The percentage of asbestos in the ACM is:

ENTER: 66 (assume we guess it is 66 % asbestos)

44.Narrative on Number of Individuals Exposed. Read and enter F2.

45.The number of individuals or building occupants that are exposed or have the potential to be exposed to the ACM in a single day is:

ENTER: 300

46.Narrative about Liabililty. Read and enter F2.

47.The ACM is visible or accessible to the following individuals: (select one)

No one

No one unless they are looking for the ACM or performing maintenance or repairs in the area

Employees or individuals that work in the area on a regular basis only.

General public

Employees and the general public

ENTER: "Employees and the general public"

48.Narrative on the Awareness of Individuals in the Area With the ACM. Read and enter F2.

49.Describe the awareness of individuals that may come in contact with the asbestos containing material in question.

Individuals are well aware that the material contains asbestos and avoid contact with it when at all possible.

Individuals are not aware that the material contains asbestos and may be prone to contacting the material.

ENTER: Place arrow beside 'Individuals are not aware that the material contains asbestos and may be prone to contacting the material.' and press return. At this time, a solid bar will appear at the bottom of the screen. This is a confidence bar and it asks what is your confidence in the answer you just gave above. Confidence may be entered using the space bar or the arrow keys. Using the space bar, confidence will be entered in tens. Using the arrow keys will enter confidence by ones.

Try pressing the space bar to see what happens. Now press the right or left arrow keys. Let's say the confidence in our answer given above is 95%. This means that we are 95% confident that individuals in the ACM area do no know that the material contains asbestos and therefore, might touch or disturb it.

Press the arrow keys until '95' is indicated by the space bar. Now press the return key.

50.Narrative on the selection of more than one answer. Read and enter F2.

51.The roof on the building containing the ACM is best described as:
(You may select more than one answer)

flat, built up roof.

a flat roof over ten years old.

having leaked in the past.

none of the above.

ENTER: Place arrow by 'flat, built up roof'. Press return. Now place arrow by 'having leaked in the past' and press return again. You have now entered these two answers (we will assume they are true as we can not tell from the picture what the roof is like). Now press key F4 to enter these answers.

52.The asbestos containing material (ACM) was sprayed on to a substrate.

ENTER: TRUE

53.The substrate on which the ACM was sprayed is:
(Select one)

tightly bound scratch or brown coat.

concrete.

steel.

wire mesh.

none of the above.

ENTER: "concrete."

3. Completing Use of the Knowledge Base.

The results and recommendations of the previous session of working with the 'Priasbes' knowledge base will appear on the screen as shown below in Figure 1.

BUILDING 65 ROOM NUMBER 101 CRITCALITY INDEX 114.00

RECOMMENDATION: Removal should be performed on the ACM at the following location: SWIMMING POOL CEILING

The ACM found in Building 65, Room Number 101, has a Criticality Index of 114.00.

Removal of the ACM in this location is recommended. The assessment for this ACM location indicates that removal is the only probable solution for stopping release of asbestos fibers into the atmosphere from the ACM. Possibly the Criticality Index is not very high but the ACM may have been damaged or saturated by water and therefore, is not amenable to control by encapsulation or enclosure.

Although removal has been recommended as the best control method amenable to this ACM location, remember, the ACM must be replaced with a non-asbestos material. However, once the ACM is removed, there is no longer a requirement to inspect the ACM and maintain it so that is will not release fatal asbestos fibers into the atmosphere.

Press key 'F2) to print a copy of this report and to continue.

Figure 1 Recommendations for the Swimming Pool Ceiling.

To print out a hard copy of the report shown in Figure 1, press key F2 to print and continue. The program will ask you if you wish to look at another location. If you do, enter 'true' and you will be returned to the beginning of the program to run through it

another time. You may go through the program as many times as you desire. If you do not wish to look at any other locations, enter 'false' and "End of Session" will appear on the screen. At this point you will be done with the knowledge base and need only press key F10 to exit.

4. Report of All ACM Locations Examined.

After running the 'Priasbes' knowledge base, you may desire a complete list of all the locations just examined by the program. If so, exit the INSIGHT II+ expert system (use the F10 key) and at the DOS prompt, A>, type:

Print form.txt

You may also just list the contents of form.txt on the screen by typing:

Type form.txt

Another way of getting a printed copy of this report is to press the print screen key while holding the shift key down. However, if the report is longer than the screen you will not obtain a copy of all of the report.

Try printing or listing the form now by following the instructions above. The results you should see are shown in Figure 2.

A REPORT OF ACM LOCATIONS

BUILDING NUMBER	ROOM NUMBER	LOCATION DESCRIPTION	CRITICALITY INDEX
65	101	SWIMMING POOL CEILING	114.00

Figure 2 Report Generated by 'Form.txt' File.

APPENDIX C

TITLE PRIORITIZING ASBESTOS REMOVAL FROM VARIOUS FACILITIES DISPLAY

PRIORITIZATION OF ASBESTOS REMOVAL FROM VARIOUS FACILITIES

by
Sharon L. Disher

Press key (F1) to continue.

This knowledge base will question you about a specific location in a facility where asbestos containing material (ACM) exists. Initially, the building number and room number where the asbestos containing material is located will need to be input. Then you will be queried as to the condition of the ACM. Specifically, you will be asked how much ACM exists, has it been damaged by water, how accessible is it to building occupants or the general public as well as some other attributes of the ACM.

These attributes will then be examined by this program and a Criticality Index will be assigned to the specific location containing the ACM. The Criticality Index indicates how critical it is for control measures to be taken by the facility manager to ensure that asbestos fibers remain intact and do not expose building occupants to dangerous asbestos fibers. Recommendations will be made as to the remedial actions to be taken based on the Criticality Index, friability of the ACM, water damage to the ACM and it's accessiblity (encapsulation, enclosure or removal).

Press key (F1) to continue.

A hard copy report will be printed out after examining each location containing ACM. This report will indicate the building number, room number, location of the ACM, the Criticality Index and the recommendations for controlling the ACM.

Additionally, this knowledge base will send all information generated concerning all of the locations that are examined to an external file named 'Form'. Once you are through looking at different locations, refer to the User Documentation to find out how to make a print out of the file 'Form'. This print out will list all locations and their Criticality Indexes so that you may compare them and thereby determine which locations are more critical than others and should be addressed or controlled first.

Please ensure your printer is turned on before continuing.

Prior to running this program it would be helpful to obtain a laboratory analysis of the asbestos content of the asbestos containing material. The asbestos content must be indicated in percent values.

NOTE: Asbestos containing material is referred to as ACM at various

```
        times throughout this program.
    Press key (F3) to continue.
!!
STRING place
STRING LOCATION
NUMERIC building number
NUMERIC room number
NUMERIC Index
NUMERIC which
SIMPLEFACT The Location Information
SIMPLEFACT'Continue
OBJECT Aware
!
FORGET ALL
!
THRESHOLD=40
CONFIDENCE Aware
MULTI The ACM is
AND   Large
AND   The roof
!
FILE form.txt
!
SUPPRESS ALL
!
1. Finished
!
!!! GET BUILDING LOCATION INFORMATION
!
RULE To get building information
IF    ASK building number
AND   ASK room number
AND   ASK place
AND   ASK which
THEN  The Location Information
AND   BLDGNO := building number
AND   ROOMNO := room number
AND   LOCATION := place
AND   Index := which
!
!!!   DETERMINE THE ASBESTOS MATERIAL CONDITION SCORE
!
RULE For Material condition score is 0
IF    DISPLAY matcon
AND   Intact
THEN  The asbestos material condition score is 0
AND   Asbestos Material Condition score
AND   Amc := 0
!
RULE For Material condition score is 1
IF    Pieces
THEN  The asbestos material condition score is 1
AND   Asbestos Material Condition score
AND   Amc := 1
!
RULE For Material condition score is 2
IF    Score \ Less
AND   DISPLAY Multi
AND   The ACM is IS breaking into layers or small chunks
OR    The ACM is IS beginning to fall to floor in small pieces
OR    The ACM is IS deteriorating in small areas
OR    The ACM is IS hanging from the ceiling or substrate
THEN  The asbestos material condition score is 2
AND   Asbestos Material Condition score
AND   Amc := 2
!
```

(2)

```
RULE For Material condition score is 5
IF   Score \ Greater
AND  DISPLAY Multi
AND  The ACM is IS severely damaged
AND  DISPLAY Multi
OR   Large \ have been dislodged
OR   Large \ have dropped to the floor
OR   Large \ are hanging from the ceiling or substrate
THEN The asbestos material condition score is 5
AND  Asbestos Material Condition score
AND  Amc := 5
!!!
!!!  DETERMINE THE SUBSTRATE TYPE SCORE
!!!
RULE Substrate type score is to be considered
IF   NOT Sprayed on
THEN The substrate score is 0
AND  Substrate score
AND  Sub := 0
!
RULE Substrate type score is 1
IF   Sprayed on
AND  Substrate\ tightly bound scratch or brown coat.
OR   Substrate\ concrete.
THEN The substrate score is 1
AND  Substrate score
AND  Sub := 1
!
RULE Substrate type score is 2
IF   Sprayed on
AND  Substrate\ steel.
OR   Substrate\ wire mesh.
THEN The substrate score is 2
AND  Substrate score
AND  Sub := 2
!
RULE Substrate type score is 0
IF   Sprayed on
AND  Substrate\ none of the above.
THEN The substrate score is 0
AND  Substrate score
AND  Sub := 0
!!!
!!!  DETERMINE THE WATER DAMAGE CONDITION SCORE
!!!
RULE For Water Damage score is 0
IF   DISPLAY Water
AND  Stains
THEN The water damage condition score is 0
AND  Water Damage Condition score
AND  Wds := 0
!
RULE For Water Damage score is 1
IF   Water has damaged\ less than.10% of the ACM
AND  Minor water
OR   No pieces of ACM have fallen to the floor
THEN The water damage condition score is 1
AND  Water Damage Condition score
AND  Wds := 1
!
RULE For Water Damage score is 2
IF   Water has damaged\ greater than 10% of the ACM
AND  Major water
OR   Fall
OR   Water fibers
THEN The water damage condition score is 2
```

```
AND  Water Damage Condition score
AND  Wds := 2
!
RULE For Roof score is 1
IF   DISPLAY Multi
AND  The roof IS  a flat, built up roof.
OR   The roof IS  a flat roof over ten years old.
OR   The roof IS having leaked in the past.
THEN The roof score is 1
AND  Roof score
AND  Rs' := 1
!
RULE For Roof score is 0
IF   The roof IS none of the above.
THEN The roof score is 0
AND  Roof score
AND  Rs := 0
!
!!!
!!!  DETERMINE THE EXPOSED SURFACE AREA SCORE
!!!
RULE For Exposed Surface Area Score is 0
IF   DISPLAY Exposure
AND  Visible
AND  Barrier
THEN The exposed surface area score is 0
AND  Exposed Surface Area score
AND  Esa := 0
!
RULE For Exposed Surface Area Score is 1
IF   Exposed\Minor exposure
THEN The exposed surface area score is 1
AND  Exposed Surface Area score
AND  Esa := 1
!
RULE For Exposed Surface Area Score is 2
IF   Exposed\ greater than 10% of the total amount of ACM.
OR   Space
THEN The exposed surface area score is 2
AND  Exposed Surface Area score
AND  Esa := 2
!!!
!!!  DETERMINE THE ASBESTOS ACCESSIBILITY SCORE
!!!
RULE For Asbestos Accessibility Score is 0
IF   DISPLAY Accessibility
AND  Access
OR   No contact
THEN The asbestos accessibility score is 0
AND  Asbestos Accessibility score
AND  Aa := 0
!
RULE For Asbestos Accessibility Score is 1
IF   Minor access
OR   Infrequent contact
OR   Thrown objects
THEN The asbestos accessibility score is 1
AND  Asbestos Accessibility score
AND  Aa := 1
!
RULE For Asbestos Accessibility Score is 4
IF   Frequent access
OR   Frequent contact
OR   Rub
THEN The asbestos accessibility score is 4
AND  Asbestos Accessibility score
```

```
AND   Aa := 4
!!!
!!!   DETERMINE THE ACTIVITY AND MOVEMENT SCORE
!!!
RULE For Activity and Movement Score is 0
IF    DISPLAY Activity
AND   area  IS a quiet admin office
OR    area  IS in a library
OR    area  IS a quiet classroom
OR    area  IS a quiet private office
OR    area  IS a study hall
OR    area  IS a storage room
OR    area  IS an electrical closet
OR    area  IS Telephone
OR    area  IS Abandoned
OR    area  IS Quiet machinery room
AND   Little movement
THEN  The activity and movement score is 0
AND   Activity and Movement score
AND   Am := 0
!
RULE For Activity and Movement Score is 1
IF    Vibrations
AND   area IS an active classroom
OR    area IS an active admin office
OR    area IS a low populated corridor
OR    area IS a restroom
THEN  The activity and movement score is 1
AND   Activity and Movement score
AND   Am := 1
!
RULE For Activity and Movement Score is 2
IF    High movement
OR    Noise
OR    Disruptive
OR    Vibrating
OR    Forklifts
OR    area IS in a cafeteria
OR    area IS in a gymnasium
OR    area IS an active workspace
OR    area IS in a swimming pool
OR    area IS a machinery room
OR    area IS a band room
OR    area IS a music practice room
OR    area IS a populated corridor
THEN  The activity and movement score is 2
AND   Activity and Movement score
AND   Am := 2
!!!
!!!   DETERMINE THE AIR PLENUM SCORE
!!!
RULE For Air Plenum Score is 0
IF    DISPLAY Air plenum
AND   No air plenum
AND   Suspended ceiling
OR    No air stream
OR    Blown
OR    Machine air currents
OR    Wind currents
THEN  The air plenum score is 0
AND   Ap := 0
AND   Air Plenum score
!
RULE For Air Plenum Score is 2
IF    Supply air
THEN  The air plenum score is 2
```

```
AND  Air Plenum score
AND  Ap := 2
ELSE The air plenum score is 1
AND  Air Plenum score
AND  Ap := 1
!!!
!!!  DETERMINE THE FRIABILITY SCORE
!!!
RULE For Friability Score is 0
IF   DISPLAY Friable
AND  Material IS Hard
THEN The friability score is 0
AND  Friability score
AND  Fs := 0
!
RULE For Friability Score is 1
IF   Material IS difficult to damage by hand pressure
AND  Impact
OR   Granules
THEN The friability score is 1
AND  Friability score
AND  Fs := 1
!
RULE For Friability Score is 2
IF   Material IS easy to dislodge, crush or pulverize
AND  Soft
OR   Powder
THEN The friability score is 2
AND  Friability score
AND  Fs := 2
!
RULE For Friability Score is 3
IF   Material IS fluffy, spongy, or flaking
AND  Fluffy
THEN The friability score is 3
AND  Friability score
AND  Fs := 3
!!
!!!  DETERMINE THE ASBESTOS CONTENT SCORE
!!!
RULE For Asbestos Content Score to be determined
IF   DISPLAY Asbestos content
AND  The asbestos content \was determined by a lab analysis
OR   The asbestos content \is being approximated by the user
THEN The asbestos content score may be determined
ELSE DISPLAY No content score
!
RULE For Asbestos Content Score is 1
IF   The percentage of asbestos in the ACM < 1.0
THEN The asbestos content score is 1
AND  Asbestos Content Score
AND  Acs := 1
!
RULE For Asbestos Content Score is 2
IF   The percentage of asbestos in the ACM >=1.0
AND  The percentage of asbestos in the ACM < 50.0
THEN The asbestos content score is 2
AND  Asbestos Content score
AND  Acs := 2
!
RULE For Asbestos Content Score is 3
IF   The percentage of asbestos in the ACM > 50.0
OR   The asbestos content \is being approximated by the user
THEN The asbestos content score is 3
AND  Asbestos Content score
AND  Acs := 3
```

```
!!!
!!!  DETERMINE NUMBER OF PEOPLE SCORE
!!!
RULE For Number of People Exposed Score is 0
IF   DISPLAY People
AND  Few =0
THEN Number of people exposed score is 0
AND  Number of people exposed score
AND  Npe := 0
!
RULE For Number of People Exposed Score is 1
IF   Few > 0
AND  Few <=5
THEN Number of people exposed score is 1
AND  Number of people exposed score
AND  Npe := 1
!
RULE For Number of People Exposed Score is 2
IF   Few > 5
AND  Few <= 15
THEN Number of people exposed score is 2
AND  Number of people exposed score
AND  Npe := 2
!
RULE For Number of People Exposed Score is 3
IF   Few > 15
AND  Few <= 25
THEN Number of people exposed score is 3
AND  Number of people exposed score
AND  Npe := 3
!
RULE For Number of People Exposed Score is 4
IF   Few > 25
THEN Number of people exposed score is 4
AND  Number of people exposed score
AND  Npe := 4
!!!
!!!  DETERMINE THE LIABILITY SCORE
!!!
RULE For Liability score is 0
IF   DISPLAY Liability
AND  Visible daily \ No one.
OR   Visible daily \ No one unless
THEN The liability score is 0
AND  Liability score
AND  Ls := 0
!
RULE For Liability score is 1
IF   Visible daily \ Employees
THEN The liability score is 1
AND  Liability score
AND  Ls := 1
!
RULE For Liability score is 2
IF   Visible daily \ General public
THEN The liability score is 2
AND  Liability score
AND  Ls := 2
!
RULE For Liability score is 3
IF   Visible daily \ E&P
THEN The liability score is 3
AND  Liability score
AND  Ls := 3
!
!!!
```

```
!!! DETERMINE THE AWARENESS SCORE
!!!
RULE For Awareness score is 0
IF   DISPLAY Awareness
AND  THRESHOLD = 90
AND  Aware\Well aware
THEN The awareness score is 0 CF 100
AND  Awareness score .
AND  Ks := 0
ELSE The awareness score is 1
AND  Awareness score
AND  Ks := 1
!
RULE For Awareness score is 2
IF   THRESHOLD = 1
AND  Aware\Not aware
THEN The awareness score is 2
AND  Awareness score
AND  Ks := 2
!
!!!!!!!!!!!
!!!!!!!!!!!
RULE For criticality index calculations
IF   THRESHOLD = 40
AND  Asbestos Material Condition score
AND  Water Damage Condition score
AND  Exposed Surface Area score
AND  Asbestos Accessibility score
AND  Activity and Movement score
AND  Air Plenum score
AND  Friability score
AND  The asbestos content score may be determined
AND  Asbestos Content score
AND  Number of people exposed score
AND  Liability score
AND  Awareness score
AND  Roof score
AND  Substrate score
THEN Criticality Index is calculated
AND  CI:=(Amc+Wds+Esa+Aa+Am+Ap+Npe+Ls+Ks+Rs+Sub) * (Fs*Acs)
!
! The Pascal program "STORE" sends information about the building containing
! the ACM to the database "FACILITY" for storage until it is printed later.
!
RULE For building info
IF   The Location Information
AND  Criticality Index is calculated
THEN Location is known
!
! For conditions where water damage exists, the ACM is highly accessible to
! building occupants, or the ACM is friable, encapsulation and enclosure are
! not proper methods of control and removal is therefore recommended.
!
RULE Encapsulation to be performed
IF   Location is known
AND  CI >= 0
AND  CI < 30
AND  Wds = 0
AND  Aa < 4
AND  Fs < 2
THEN Encapsulation should be performed
AND  DISPLAY Encapsulation
AND  PRINT Encapsulation
!
RULE Enclosure to be performed
IF   Location is known
```

```
AND  CI >= 30
AND  CI< 60
AND  Wds = 0
AND  Aa < 4
AND  Fs < 2
THEN Enclosure should be performed
AND  DISPLAY Enclosure
AND  PRINT Enclosure
!
RULE Removal to be performed
IF   Location is known
AND  CI >= 60
OR   Wds > 0
OR   Aa = 4
OR   Fs >= 2
THEN Removal should be performed
AND  DISPLAY Removal
AND  PRINT Removal
!
RULE For standard form
IF   which = 1
THEN Continue
AND  FILE standard format
!
!! Save information in the file 'form'
!
RULE To save information in file 'form'
IF   Encapsulation should be performed
OR   Enclosure should be performed
OR   Removal should be performed
OR   Continue
THEN Save
AND  FILE list
!!!
!!!  PERFORM ANOTHER ASSESSMENT?
!!!
RULE To examine another location
IF   Save
AND  Go on
THEN Examine Another
AND  CYCLE
ELSE NOT Examine Another
!
RULE We are finished if
IF   NOT Examine Another
THEN Finished
AND  STOP
!
$ PRIS1.PRL
!
```

TEXT which

(10)

Input which location this is (e.g. if it is the first location being lo
at input 1, if the second, input 2, etc.)

!
TEXT place

Briefly describe the location of the asbestos containing material:
(in 35 characters or less) (Press return key when done)

!
TEXT area

The asbestos containing area is: (Select one. To view additiona
areas available for selection,
press key (F1) before making y
final selection.)

!
TEXT General Public
General Public only (includes students or users of the building)
!
TEXT The ACM is

The ACM is: (You may select more than one answer.)

!
TEXT Go on

Do you wish to assess another location?

!
TEXT The roof

The roof on the building containing the ACM is best described as:
(You may select more than one answer.)

!
TEXT building number

What is the number of the building containing the asbestos containing materi

(Input up to six numerals, no alpha numeric characters are allowed.)
(Press return key when done.)

!
TEXT room number

What is the room number of the room containing the ACM?

(Input up to six numerals, no alpha numeric characters are allowed.)
(Press return key when done.)

!
TEXT Substrate

The substrate on which the ACM was sprayed is:
(Select one)

!
TEXT Sprayed on

The asbestos containing material (ACM) was sprayed on to a substrate.

!
TEXT Visible daily

The ACM is visible or accessible to the following individuals:
(Select one)

!
TEXT No one unless
No one unless they are looking for the ACM or performing maintenance or repairs in the area.
!
TEXT Employees
Employees or individuals that work in the area on a regular basis only.
!
TEXT E&P
Employees and the general public.
!
TEXT Aware

Describe the awareness of individuals that may come in contact with the asbestos containing material in question:

!
TEXT Well aware
Individuals are well aware that the material contains asbestos and avoid contact with it when at all possible.
!
TEXT Not aware
Individuals are not aware that the material contains asbestos and may be prone to contacting the material.
!
TEXT Few

The number of individuals or building occupants that are exposed or have the potential to be exposed to the ACM in a single day.

!
TEXT Visible

The asbestos containing material is not visible without removing some physical barrier such as suspended ceiling acoustical tiles.

!
TEXT Barrier

The physical barrier enclosing the asbestos containing material (ACM) is not damaged so that the ACM would be exposed to building occupants.

!
TEXT Exposed

The asbestos containing material (ACM) visible to building occupants is:

!
TEXT Minor exposure
10% or less of the total amount of ACM. (For instance, some ceiling tiles may have been removed or voids (however slight), may exist in the barrier that might allow some asbestos fibers to pass through it.

!

TEXT Space

(12)

The asbestos containing material (ACM) is in a space above a suspended ceiling and this space is used as an air plenum.

!

TEXT Intact

Material is intact and shows no signs of delamination, cracking or deterioration.

!

TEXT Pieces

The asbestos containing material appears to be intact in most areas, however, pieces smaller than a half-dollar have been dislodged and may or may not have fallen to the floor.

!

TEXT Score

The area of damaged asbestos containing material (ACM) is

!

TEXT Less

less than 10% of the total amount of ACM.

!

TEXT Greater

greater than 10% of the total amount of ACM.

!

TEXT Large

Pieces of ACM larger than an half-dollar: (You may select more than one answer.)

!

TEXT Stains

There are no water stains in the vicinity of the asbestos and there is no evidence of material being disturbed by water.

!

TEXT Minor water

Small areas on or around the asbestos containing material (ACM) show evidence of water damage, ie. small stains, slight buckling.

!

TEXT Major water

Some of the asbestos containing material (ACM) has been dislodged by water.

!

TEXT Fall

The ACM has started to break loose or is saturated with water to the point that it may break loose or fall.

!

TEXT Water fibers

Water infiltration has carried fibers to another location or surface in the room and those fibers will be released into the air once the water evaporates

!

TEXT Access

(13)

Access to the material is extremely limited. For instance, the ACM might be concealed above a tight suspended ceiling or behind ductwork or piping.
!
TEXT No contact

Building occupants can not come in contact with or throw objects (such as basketballs or pencils) at the asbestos containing material (ACM).
!
TEXT Minor access

The asbestos containing material (ACM) is rarely accessible. Most often the area containing the ACM is vacant of people.
!
TEXT Infrequent contact

ACM is usually only contacted when infrequent maintenance or repairs are performed.
!
TEXT Thrown objects

The ACM is rarely touched by building occupants and rarely are objects thrown at it.
!
TEXT Frequent access

Building occupants frequently contact the asbestos containing material (ACM) or throw objects at it.
!
TEXT Frequent contact

Contact may be made during periods of frequent maintenance.
!
TEXT Rub

Building occupants hit or rub against the ACM during normal activity, ie. on walls in a hallway, or on the ceilings in a hallway where individuals jump up and scrape the ACM.
!
TEXT Little movement

There is very little or no movement in the room or area containing the ACM. The occupants of this area are quiet and non-destructive.
!
TEXT Telephone
a telephone equipment closet
!
TEXT Abandoned
an abandoned machinery room
!
TEXT Quiet machinery room
a machinery room where very little personnel or vibratory movement takes place
!
TEXT Vibrations

The asbestos containing material (ACM) is in an area where activities take place that cause vibrations which may have the potential of releasing asbesto fibers from the ACM. Such activities include playing musical instruments, starting up or shutting down large machines, running noisy machinery, singing or shouting loudly, stamping feet, etc.

!

TEXT High movement

(14)

There are high levels of activity and movement in the area or room containir the asbestos containing material (ACM).

!

TEXT Noise

Occupants of the area create high noise levels.

!

TEXT Vibrating

The asbestos containing material is wrapped around components such as pipes or ducts that vibrate or move.

!

TEXT Forklifts

There are machines or personnel with equipment in the area that may bump into the ACM and knock it loose, e.g., forklifts or small carts or trolleys

!

TEXT Disruptive

Occupants of the area are disruptive, destructive or vandalous when performing their activities.

!

TEXT No air plenum

No air plenum, air vents or outlets exist in the asbestos containing area.

!

TEXT Suspended ceiling

There is no area above a suspended ceiling being utilized as an air plenum.

!

TEXT No air stream

There is no direct air stream present in the room.

!

TEXT Blown

No air is being directly blown on friable asbestos material.

!

TEXT Machine air currents

Movement by machines in area containing the ACM will not set up air current

!

TEXT Wind currents

There are no drafts or air streams set up by winds from outside the building such as through an open window or in a large bay area.

!

TEXT Supply air

(15)

Air is being supplied to the room through supply vents or ducts.

!

TEXT Material

Asbestos containing material is:
(Select one)

!

TEXT Hard

hard and can not be damaged by hand pressure. Sharp tools are required to penetrate the material.

!

TEXT Impact

The asbestos containing material (ACM) can be indented by forceful impact.

!

TEXT Granules

If rubbed, the ACM leaves granules on the hand but no powder residue.

!

TEXT Soft

The asbestos containing material (ACM) may be removed in small or large piec is soft and can be damaged by hand pressure.

!

TEXT Powder

Rubbing the ACM leaves a powder residue on the hand.

!

TEXT Fluffy

Minimal hand pressure will cause the asbestos containing material to fall apart or disintegrate. Pieces of the ACM may be hanging from its substrate.

! ----------

!

DISPLAY standard format

A REPORT OF ACM LOCATIONS

BUILDING NUMBER	ROOM NUMBER	LOCATION DESCRIPTION	CRITICALITY INDE

!

DISPLAY list

[BLDGNO(6,0)] [ROOMNO(6,0)] [LOCATION(35)] [CI(6,2)]

!

DISPLAY Water

Water Damage

Infiltration of water into asbestos containing material (ACM) can cause the ACM to delaminate and/or break apart as well as dissolve the binder which holds the asbestos fibers together. When the binder in ACM breaks down the potential for fiber release increases greatly. Water damage ca result from roof or skylight leaks, plumbing leaks, spills in a laboratory, humidity in the area of a swimming pool or sauna, or a variety of other sources.

It is important to recognize water damage or the potential for water dam to ACM when prioritizing areas for asbestos control.

NOTE: When water damage is discussed in this program, it should be understood that water damage is any damage to ACM by a liquid substance that delamination or break down of the binder in the ACM is a probabili

Press key (F2) to continue.

!
DISPLAY People

Number of People Exposed to the Asbestos Containing Material (ACM)

The number of individuals that are currently being exposed to the ACM or those that may be potentially exposed must be taken into account when determining the method of asbestos control most suited for a particular problem area.

The requirement to control the ACM becomes more critical as the number of individuals exposed or potentially exposed to it increases.

For instance, say the ACM is in a storage closet which is normally locked and only one or two janitors have the key to gain access to the closet. This situation would be less critical than that of ACM in a classroom with the capacity to accomodate up to fifty (50) individu

You will now be asked to identify the number of individuals that are being exposed or may potentially be exposed to the ACM.

Press key (F2) to continue.

!
DISPLAY matcon

Asbestos Containing Material Condition

The most important factor used to determine whether asbestos fibers have been released is the asbestos containing mateial condition.

When answering the following questions, take into account how well the material adheres to its substrate, debris on the floor around or below the material, and damage to the material due to vandalism, water, or cracking.

Press key (F2) to continue.

!
DISPLAY Multi

More than one answer may be selected for the following question.

To select more than one answer, position the arrow to one answer at a time and press return. The answer(s) you have selected will be highlighted. When you are through making your selections, press key (F4) to continue.

Highlighting may be removed from selected items by pressing the return key a second time before pressing (F4).

Press key (F2) to continue.

!
DISPLAY Exposure

Exposed Surface Area

(17)

Exposure of the asbestos containing material (ACM) to building occupants increases the likelihood of the ACM being disturbed and releasing fibers into the atmosphere.

ACM is considered to be exposed if it can be seen by building occupants, ie. there is no physical barrier blocking one's view of the ACM.

Press key (F2) to continue.

!

DISPLAY Accessibility

Accessibility to the Asbestos Containing Material (ACM)

The accessibility of building occupants to the ACM directly relates to the potential of someone deliberately or accidentally rubbing against or contacting the ACM and causing asbestos fibers to be released.

Increased accessibility increases the likelihood that the ACM will be contacted and fibers will be released into the atmosphere.

Inaccessible ACM might be located behind a suspended ceiling, or in a locked storage room. It would be in a location usually vacant with little chance of anyone contacting the material such as by rubbing against it or throwing objects at it.

Press key (F2) to continue.

!

DISPLAY Activity

Activity and Movement

Disturbance of asbestos containing material (ACM) is directly related to the amount of activity and movement that takes place in the vicinity of the ACM. When considering activity, take into account the movement of people and high vibrations caused by machinery, adjacent rooms, nearby highways, or high noise levels such as those in a band room or auditorium.

Press key (F2) to continue.

!

DISPLAY Air plenum

Presence of Air Plenums or Direct Air Streams

The presence of an air plenum or return or supply vents in a room containing asbestos containing material (ACM), increases the potential of asbestos fibers becoming airborne or being distributed to other areas within a building. Therefore, the presence of supply outlets, return vents or air plenums above suspended ceilings in the area containing the ACM should be noted by the individual performing the asbestos survey.

Press key (F2) to continue.

!

DISPLAY Friable

Friability of Asbestos Containing Material (ACM):

(18)

Friable means that the ACM can be crushed or pulverized by hand pressure. There are varying degrees of friability. The more friable an ACM, the greater the potential for asbestos fiber release. The individual performing the asbestos survey will need to determine how difficult it is to damage or cause the ACM to release fibers by touching the material. Spray applied ACM is generally more friable than trowel applied material.

Press key (F2) to continue.

!

DISPLAY Asbestos content

Asbestos Content

The asbestos content of the ACM must either be determined by a laboratory analysis where results are given in percentages or approximated by the user of this knowledge base.

Press key (F2) to continue.

!

DISPLAY No content score

The Criticality Index can not be determined without a laboratory analysis of the ACM or an approximation by the user.

Please have a sample analyzed by a laboratory or approximate the asbestos content and restart this program. Unfortutunately, all data previously entered will be lost and must be reentered.

!

DISPLAY Encapsulation

BUILDING[BLDGNO(6,0)] ROOM NUMBER[ROOMNO(6,0)] CRITICALITY INDEX [CI(6,2)]

RECOMMENDATION: Encapsulation should be performed on the ACM at the following location: [LOCATION (35)]

The ACM found in Building[BLDGNO (6,0)], Room Number[ROOMNO (6,0)] has a Criticality Index of [CI(6,2)].

This Index along with the other information provided about the asbestos containing material indicates that the corrective action to be taken is of no immediate priority. Scheduled inspections of the material and possibly encapsulation of the ACM should be performed.

Of course, encapsulation is contingent upon the thickness of the ACM and it's compatibility with sealants available on the market.

Also, keep in mind, encapsulation may have to be performed again at a later date if the sealant loses it's ability to hold the ACM together. Inspections frequent enough to determine if this is happening are a must.

Press key (F2) to print a copy of this report and to continue.

!

DISPLAY Enclosure

BUILDING[BLDGNO(6,0)] ROOM NUMBER[ROOMNO(6,0)] CRITICALITY INDEX [CI(6,2)]

RECOMMENDATION: Enclosure should be performed on the ACM at the following location: [LOCATION (35)]

The ACM found in Building[BLDGNO (6,0)], Room Number[ROOMNO (6,0)] has a Criticality Index of [CI(6,2)].

Enclosure is recommended for this location of ACM. This means that the ACM should be enclosed or sealed off from the surrounding atmosphere in order to ensure that it's asbestos fibers are contained. Enclosure must be done with a non-asbestos material. Encapsulation might be performed once the enclosure around the ACM is in place. When enclosing ACM as a means of controlling the asbestos fibers, remember that the enclosure must have tight seams in order to keep the fibers from becoming airborne.

Press key (F2) to print a copy of this report and to continue.

!

DISPLAY Removal

BUILDING[BLDGNO(6,0)] ROOM NUMBER[ROOMNO(6,0)] CRITICALITY INDEX [CI(6,2)]

RECOMMENDATION: Removal should be performed on the ACM at the following location: [LOCATION (35)]

The ACM found in Building[BLDGNO (6,0)], Room Number[ROOMNO (6,0)] has a Criticality Index of [CI(6,2)].

Removal of the ACM in this location is recommended. The assessment for this ACM location indicates that removal is the only probable solution for stopping release of asbestos fibers into the atmosphere from the ACM. It is possible that the Criticality Index may not be very high, however, the ACM may have been damaged or saturated by water. If this is true, this ACM location is not amenable to control by encapsulation or enclosure.

Although removal has been recommended as the best control method amenable to this ACM location, the ACM must be replaced with a non-asbestos material. Once the ACM is removed, however, there is no longer a requirement to inspect the ACM and maintain it so that it will not release fatal asbestos fibers into the atmosphere.

Press key (F2) to print a copy of this report and to continue.

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DISPLAY Liability

Liability Concerns

Asbestos containing material (ACM) accessible or visible to the public can damage the reputation of a firm or institution if significant action is not taken to control it. The increased awareness of the public on the fatal affects of asbestos makes it's presence a very sensitive liability issue and thereby increases a firm's responsibility to take measures to control the asbestos.

This fact does not necessarily apply to those areas containing ACM which is not readily accessible to the public. For instance, pipes wrapped with asbestos lagging back behind a boiler in a machinery room would apply in this case. The same is true of ACM in a storage room normally accessed by specific individuals only.

The following question will query you as to the nature of the traffic in the area containing the ACM.

Press key (F2) to continue.

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DISPLAY Awareness

Awareness of Individuals in Area Containing ACM

When determining priority of removal or extent of control methods, one must ask "how aware are the individuals that may come in contact with the asbestos containing material that the material contains asbestos and therefore should not be contacted in any way?"

Your confidence in your answer will be asked for once you have answered the question. This will be done by the presence of a bar on the screen.

Confidence may be entered along this bar in percentages from 0 to 100. Press the space bar until the bar appearing on the screen indicates the degree of confidence in your answer. Press return to enter your confidence level.

Press key (F2) to continue.

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END